TOBACCO PRODUCTION

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
AGRICULTURE INFORMATION BULLETIN NO. 245

CONTENTS

Washington, D. C. Revised December, 1976

TOBACCO PRODUCTION

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Tobacco is an important cash crop with a high acre value but production costs are high and hazards are numerous. From the seedbed to the completion of curing, the grower is confronted with complex cultural, disease, insect, and handling problems that have a direct influence on the quality and value of the crop.

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A combination of soil and climatic conditions, methods of curing, fertilization, and varieties all help to provide conditions necessary for producing each of the eight major types of tobacco.

Tobacco is grown worldwide under a vast range of climatic conditions and on many soil types. Nearly all tobacco in the United States is grown east of the Mississippi River. (fig.1).

Different growing areas have soils and climate for different types of tobacco leaf, each of which possesses well-recognized

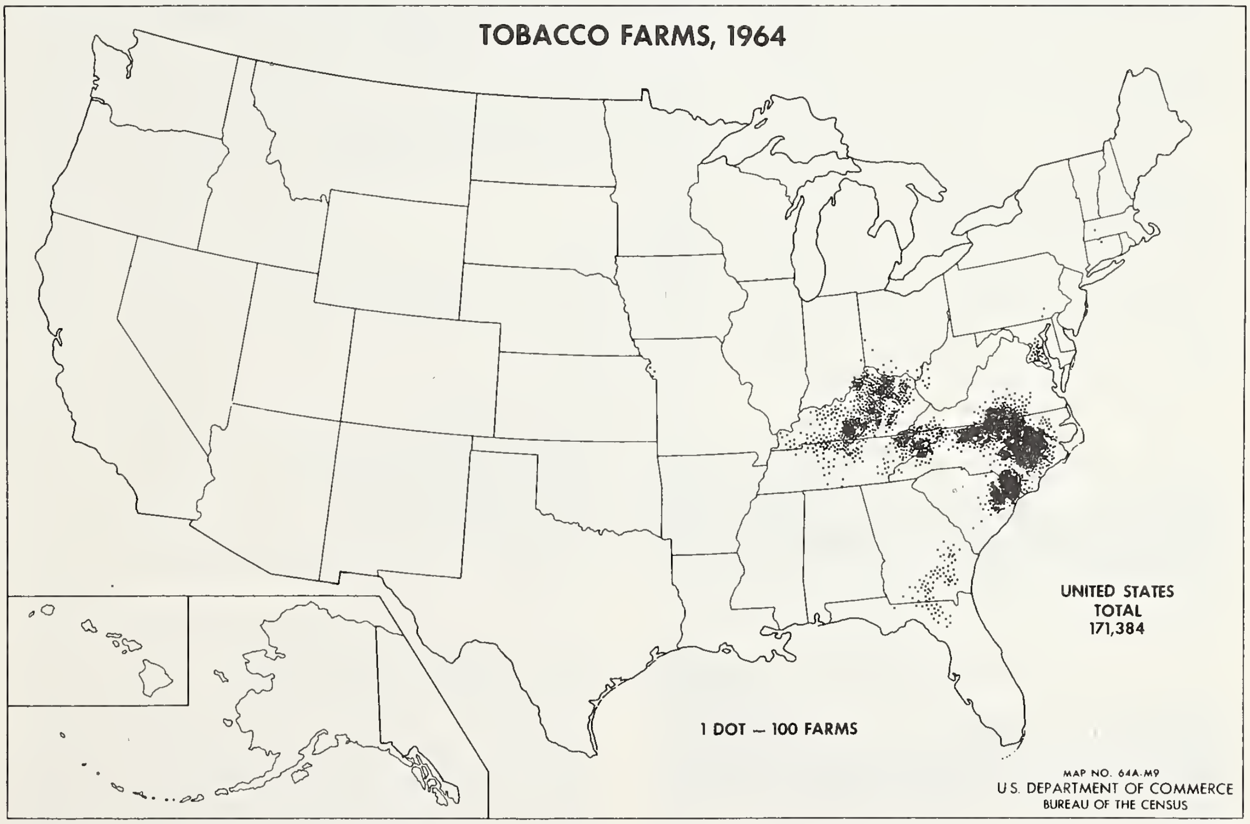

FIGURE 1.—Number and locations of tobacco farms in the United States.

characteristics. The tobacco industry looks to these areas to obtain supplies of various kinds of leaf necessary to meet consumer demand.

As a rule, it is not profitable to grow tobacco outside the established areas. The cured leaf may not be acceptable as to type and marketing facilities may not be available. Usually, tobacco growers in established areas have the needed know-how, equipment, and facilities to increase, if necessary, their acreage to meet any increased demand.

TYPES OF LEAF TOBACCO

Tobacco types are not usually interchangeable in the manufacture of tobacco products. For example, such cigarette tobaccos as flue-cured and burley are not generally used in the manufacture of cigars. Leaf for cigarettes and pipe smoking is primarily from flue-cured and light air-cured types. Leaf for cigar manufacturing is known as filler, binder, and wrapper.

The U.S. department of Agriculture has established an official system of classification for tobacco. Each class and type is designated by number and the grades of leaf within the type are indicated by a series of symbols covering the principal characteristics and quality of the product (table 1). The type names have established use-value relationships that are well recognized by the trade.

TABLE 1.—*Classes and types of tobacco established by the U.S. Department of Agriculture*

Type of curing and class	Type	Type name or locality
Flue-cured, Class 1	11A	Old Belt—Virginia and North Carolina
	11B	Middle Belt—North Carolina
	12	Eastern Belt—North Carolina
	13	Border Belt—South Carolina and Southeastern North Carolina
	14	Georgia and Florida
Fire-cured, Class 2	21	Virginia
	22	Eastern—Kentucky and Tennessee
	23	Western—Kentucky and Tennessee
Air-cured		
Class 3A (light air-cured)	31	Burley
	32	Maryland
Class 3B (dark air-cured)	35	One-Sucker
	36	Green River
	37	Virginia Sun-Cured
Class 4 (Cigar Filler)	41	Pennsylvania Seedleaf, or Broadleaf
	42	Gebhardt
	43	Zimmer Spanish
	44	Little Dutch
	46	Puerto Rico
Class 5 (Cigar Binder)	51	Connecticut Broadleaf
	52	Connecticut Havana Seed
	53	New York and Pennsylvania Havana Seed
	54	Southern Wisconsin Havana Seed
	55	Northern Wisconsin Havana Seed
Class 6 (Cigar Wrapper)	61	Connecticut Valley Shade-Grown
	62	Georgia and Florida Shade-Grown
Miscellaneous, Class 7	72	Louisiana Perique

GENERAL CULTURAL PRACTICES

Practices for seedbed culture are much the same for all areas with modifications to take care of differences in soil and climate. Field preparation and fertilizing practices are much the same as those for other crops in the same area. The general cultural practices discussed in this section for all types of tobacco are not included in the discussion of the specific cultural requirements for each tobacco type.

Seedbed Culture

All commerical tobacco plants are grown in a seedbed and later transplanted to the field. Successful tobacco culture depends on a good supply of well-developed, healthy seedlings at the proper time for transplanting. Seedlings are difficult to produce because of weeds, diseases, nematodes, and insects.

Location

The tobacco seedbed should be near windbreaks and where water is available. If the soil structure can be maintained, a permanent site that has fertile soil, good drainage, and a southern or eastern exposure is best.

The bed should be some distance from the curing barns to avoid contamination of diseases from the previous crops that may be on the old leaves around the barn. The distance from the barn depends on the slope and drainage. If the water does not drain from the barn to the plant bed site, 200 or 300 feet is sufficient; however, if drainage is toward the plant bed, you may need 1,000 feet or more. Also, the plant bed should be situated so that drainage from old tobacco beds or fields does not contaminate it or its water supply. In the burley area, the best place to prepare the seedbed is in an open field where a heavy grass sod has grown for several years. An animal-tight fence around the bed will prevent damage by dogs or other animals.

In general, if plant beds are prepared just prior to seeding, all plant material should be removed, including brush and weeds; if not the seed will not germinate well. If the beds are disked in the fall, most of the cover crops or weeds can be disked in; however, large brush and woody vegetation should be taken off. In some areas, especially Pennsylvania, a liberal application of manure is plowed under in the fall. The soil is pulverized and usually leveled prior to sterilization or treatment for pest control.

Soils should be in good physical condition. In preparing the bed, plow or disk it to the center. This tends to give a slight buildup in the center which aids in drainage. After the soil is broken, it should be harrowed and raked until it is well pulverized, smooth, and free of clods. It is important to have the seebed smooth because tobacco seed is very small and germination is very poor if the bed is not smooth.

Construction

The seedbed, often referred to as a plant bed, may be any convenient size and shape, but pesticides for the control of diseases and insects are hard to apply on beds more than 3 yards wide. With this width or less, a board can be placed on the board walls of the seedbed as a walkway for applying pesticides, weeding, or pulling plants. In wide beds, an alley every 3 yards down the length of the bed may help prevent contamination of the soil by soilborne disease organisms.

In most areas except the flue-cured area, boards are set on edge to a height of 6 to 10 inches to surround the seedbed and form a coldframe. Wires, poles, or strings are placed across the frame to support a tobacco cloth that is used to cover the seedbed. A special cotton cloth of 24 by 28 threads per square inch is used in southern areas, and 28 by 32 threads in northern areas (fig. 2). The cloth helps protect the seedlings from cold and insects and reduces soil drying.

Light mulches of weed-free straw or pine needles are often used as extra covers; extra cloth or plastic covers are sometimes used in extremely cold weather. In many areas, the cloth is laid on a light mulch and attached directly to the ground with wires through metal eyelets at the edges of the cloth rather than attached to boards or logs and suspended above the ground.

As soon as the seedlings begin to elongate (tobacco seedlings grow flat on the ground until they have about four to six leaves and then they begin to elongate) the cover is removed. Twigs are then bent in the fashion of a bow and each end is put in the ground. The cover is then replaced and the twigs hold the cover off the

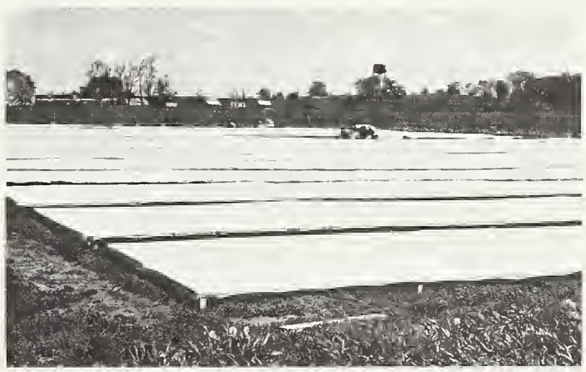

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FIGURE 2.—Tobacco seedbeds at Lexington, Kentucky.

plants. About 10 days prior to transplanting, the cover is removed. If danger of frost is encountered, the cover is put back on.

The straw bed is popular in the flue-cured area. This bed eliminates the boards or logs at the border. The bed is made by spreading a reasonably thin coat of clean wheat or oat straw or pine needles over the bed area. The cloth cover is place directly over the straw and pegged down around the edges.

The straw covering retains moisture better, keeps the bed warmer, and gives more protection from extreme cold than the coldframe bed. Also, a straw bed usually produces plants 2 weeks earlier than the coldframe bed and is much easier and cheaper to build (fig. 3).

Plastic-covered beds are popular in Georgia and Florida and are becoming important in all flue-cured areas. Translucent, 3 to 4 mil, polyethylene film is used to cover the beds. Frames and covers are installed immediately after seeding. Rough 1- by 6-inch to 1- by 10-inch boards can be used around the sides and ends of the bed and a 1- by 4-inch board can be used for a center ridge, which is installed about 20 inches above ground. Smooth, 1- by 2-inch, arched rafters spaced 4 to 6 feet apart are nailed to the top of the sideboards and the center ridge to support the cover. The plastic cover is then stretched reasonably tight over the frame and attached to the sideboards by nailing a 1- by 2-inch strip of wood along the sideboards over the edge of the plastic (fig. 4).

Heavy twine pulled across the top of the plastic cover at 4-to 6-foot intervals and fastened to the wooden sides will help keep the cover from flapping in windy weather. Endboards should have openings in them for ventilation. The

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FIGURE 3.—Straw-type seedbeds in South Carolina.

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FIGURE 4.—Plastic-type seedbeds in Georgia.

temperature should not be above 85°F. under the plastic or about 75° outside. Ventilation is important because high temperature will burn the plants. About ¼ to ½ inch of water should be applied when the soil becomes dry to the touch. Success with plastic has been obtained by using perforated plastic or by punching numerous holes in solid plastic which provides ventilation and also allows rain to get in. This system is good when the plastic is used the same as covers described for straw beds. Plastic covered beds require less water than cloth-covered beds.

Plants grown under plastic are tender and generally need hardening off, which may be done by removing the cover at least 5 days before transplanting. Compared to production under cloth, plant production under plastic generally requires only about two-thirds the time, about one-half the fertilizer, less seed and water, and less risk of cold weather damage.

Plants in the shade areas of Florida are grown in beds that are protected much the same as the shade-grown commercial crop. The cover is 7 to 8 feet above the plants. A cover like this can be used in Florida because of the warm climate.

In Louisiana, the seedbeds of perique tobacco are left uncovered, except for the first 10 or 12 days when the beds are protected with loose brush or palm fronds laid directly on the ground.

In cold areas, principally Connecticut and Massachusetts, glass sash commonly covers the seedbeds (fig. 5). Plastic is sometimes substituted for glass or cloth.

Treatment for weed and pest control

Control of weeds, diseases, nematodes, and insects is very important. Some method of soil teatment usually is practiced. The soil may be

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FIGURE 5.—Tobacco seedbeds in Connecticut. Small plants grown under glass.

treated in the fall or spring if adequate precautions are taken to avoid recontamination, but fall is the preferable time.

Some of the more common weeds in the plant beds are crabgrass, lambsquarter, smartweed, pigweed, and iron weed.

Hand weeding may be necessary. However, when weeds are removed by hand, many tobacco seedlings are destroyed and tobacco mosaic and other diseases are often spread as a result of handling tobacco plants and walking on the seedbed area.

Methyl bromide gas is the most widely used material for seedbed treatment. It controls most soilborne diseases, weeds, and nematodes and it provides temporary control of many soil insects. Methyl bromide is available in 1-pound pressurized cans and the recommended rate is 9 pounds per 100 square yards (fig. 6). The material should be applied to well-pulverized seedbeds. Polyethylene plastic is placed over the beds with the edges sealed tightly around each bed to prevent the gas from escaping. The gas is then put under the cover through a tube. After treatment, the cover should remain on the beds from 24 to 48 hours depending on the temperature. For best results, methyl bromide should be applied when the soil temperature is between 50° and 70°F. Seeding must be delayed at least 48 hours after removal of the cover.

Methyl bromide is a poisonous gas, and the detailed precautions furnished with the material should be closely observed. Some users employ trained personnel to apply it.

Steam sterilization of seedbeds is used in some areas, principally Wisconsin and Pennsylvania. This method reduces to a minimum the hazard from weeds, diseases, nematodes, and insects. A steam boiler is used to force steam into the soil either with an inverted pan or with buried drills.

Several chemicals have been used for plant bed treatment to control weeds, soil fungi, nematodes, and insects. Chloropicrin, or tear gas, is an effective compound; but, because of difficulty in application, is not widely used.

Chemicals commonly used are: (1) SMDC (sodium methyldithiocarbamate)—This compound is normally applied as a drench; (2) Dazomet (tetrahydro-3-5-dimethyl-2H-1,3,5-thiadiazine-2-thione)—This is applied in the top surface and then watered; (3) a mixture containing methyl isothiocyanate and DD (1,3-dichloropropene-1, 2-dichloropropane)—This is normally applied by commercial operators by chisel and then covered with a plasic film.

Fertilizer rates

After the seedbed is prepared and treated, fertilizer is broadcast at the approximate rates shown in table 2 and incorporated in the soil to a depth of 2 inches. The soil should not be stirred deeper than 2 inches because weed seed not killed by the treatment may be brought to the

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FIGURE 6.—Tobacco seedbed in Tifton, Ga., showing polyethylene cover after being treated with methyl bromide.

surface. Additional fertilizer may be needed for the seedlings, as explained in the section on management of seedbeds.

Organic forms of nitrogen may increase the development of damping off diseases. At least 35 to 50 percent of the nitrogen in the preplant fertilizer should be from nitrate nitrogen where beds have been fumigated. In fumigated beds, conversion from ammonium nitrogen to nitrate nitrogen may be delayed.

Seeding

Clean seed with a germination of 70 percent or better is the best insurance for a good stand. If seed with a lower germination has to be used, the rate of seeding should be increased. Seeding rate is important. If the seed is sown too thickly, plants may be delicate and spindly and if the seed is sown too thinly, plants may be short, stocky, and poorly suited for transplanting (fig. 7).

The seed is usually mixed with inert materials, such as sifted wood ashes, land plaster (calcium sulfate), sand, bonemeal, or other light-colored material that will show the distribution of seeding. A measured amount of the seed mixture is spread over definite area so that even distribution is accomplished. The rate and time of seeding by tobacco types is shown in table 3.

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FIGURE 7.—Seedbed in southern Georgia, showing excellent stand of tobacco plants about ready for transplanting.

The seedbed should be gone over several times to help insure even distribution. If the seed is mixed with fertilizer, the mixture should be spread immediately to avoid injury to seed germination. The seed should be barely covered with soil by very light raking, trampling, or rolling.

Management

Where permanent seedbed sites are used, it is desirable to have at least two sites that can be rotated. Small grains and legumes that are

TABLE 2.—*Rates of commercial fertilizer for seedbeds planted to different types of tobacco* [1]

Tobacco type	Fertilizer mixture[2]				
	N[3]	P2 O5	K2 O	MgO	Rate per square yard
	percent	*percent*	*percent*	*percent*	*pounds*
Flue-cured	4 to 6	9 to 10	3 to 4	1	*1 to 2*
Fire-cured	4	12	8		½
Air-cured					
Burley	4	9 to 16	3 to 8		½ to 1½
Maryland	7	7	7	1	½
Dark air-cured	4	12	8		½
Cigar filler	4 to 6	8	4 to 12		*1*
Wisconsin Havana seed	8	4	8		¼ to ½
Shade grown cigar wrapper	8	4 to 8	8		½ to ¾
Perique[4]					

[1]The rates should be reduced for plastic covered beds.
[2]Use a minimum of chlorine.
[3]When the beds have been fumigated, 35 to 50 percent of the nitrogen in the preplant fertilizer should be from nitrate nitrogen.
[4]Fertilizer consists of nitrate of soda alone or mixed with ammonium sulfate, which may be applied prior to seeding or as a topdressing to the seedlings.

TABLE 3.—*Approximate seeding time and seedbed area and acreage that can be planted from an ounce of seed of various tobacco types*

Tobacco type	Seeding time	One ounce of[1] seed for— Seed bed	Field transplants
		square yards	*acres*
Flue-cured	Late December through March[2]	600	4 to 5
Fire-cured	February and March	400	4 to 6
Air cured			
Burley	Late February and early March	400	3 to 4
Maryland	February and March	300	3 to 4
Dark air-cured	February and early March	400	4 to 6
Cigar filler	Middle March to middle April	100	3 to 4
Wisconsin Havana seed	April and early May[3]	100	6 to 8
Shade-grown wrapper	Middle March to middle April for Connecticut; late December to early January for Florida-Georgia area	100	3 to 4
Puerto Rico	August and early September	100	3 to 4
Perique	Late December and early January	200	4 to 6

[1]This rate is ample if seed with a germination rate of 70 percent or more is used and if the seedbed is well prepared and treated; however, more seedbed area is usually planted than needed to insure an adequate supply of seedlings for transplanting.
[2]Seeding time should be delayed when plastic covers are used.
[3]If grown under glass, allow 6 to 8 weeks from seed germination to transplanting; if grown under cloth, allow 8 to 10 weeks. Under Wisconsin conditions from mid-April to May 10, only 5 to 6 weeks are required from seed germination to transplanting.

resistant to nematodes, such as soybeans and velvet beans, are desirable as rotation crops. Plant a similar crop on the beds after transplanting has been completed and the old plants discarded. Destroy unused plants as soon as transplanting is completed.

Watch the seedlings closely to determine their need for water and fertilizer. When the seedlings are germinating, the top of the soil should not dry out. After the stand is established, they should not wilt. If the plants begin to turn yellow or are stunted, additional fertilizer may be applied.

During early growth, seedlings should be protected from extremely cold temperatures by extra covers. If plastic is used, plastic will protect against extreme cold. Any kind of cotton material or other cover the grower may have can be used, and as soon as the cold is over, the extra cover is removed. Seed planted too early may germinate, but may be killed by very low temperature later.

If plants turn yellow or are growing slowly due to lack of nutrients, growth may be stimulated by supplying one or more applications of fertilizer, usually nitrogen. Sometimes the plants become yellow and the leaf margins roll inward or cup-up. It is believed this condition results from the elimination of nitrifying bacteria by the methyl bromide treatment. Nitrate nitrogen and warm weather will generally eliminate this condition.

To correct nitrogen deficiency, 5 pounds of nitrate of soda either dissolved in 50 gallons of water or dry pellet form should be applied to each 100 square yards of seedbed. Where potash starvation becomes evident, nitrate of potash is applied at the same rate to correct slow and abnormal growth. After application, the fertilizer must be washed immediately from the leaves of the seedlings to prevent burning.

Nitrogen deficiency is manifested by yellowing of the plants. Excess moisture will also turn the plants yellow; however, a grower should know whether or not he has had too much moisture. Potash deficiency is manifested by browning of the margin of the leaves and the plants may actually die, however, diseases, or an excess of fertilizer will cause some of the same symptoms. A grower should consult his county agent if he is having these troubles.

In cases of overfertilization, the beds should be watered generously without additional fertilizer.

Diseases and insects must be controlled in the seedbed to avoid destruction or delayed growth and to avoid spreading diseases and pests to the field. See the sections on diseases and insects for control measures.

Plants are ready for transplanting by hand when they have four to six fair-sized leaves and are 5 to 6 inches high (fig. 8). Plants 6 to 9 inches high are best if machine transplanters are used. Seedlings should be hardened by removing the seedbed covers 5 to 10 days before transplanting.

To avoid root damage, the soil should be thoroughly moistened before pulling the plants. Plants of the same size should be pulled individually from the bed and placed upright in baskets or small boxes for transporting to the field. The roots must be kept moist until transplanting.

Field Preparation and Fertilizer Application

Thorough preparation of the soil helps the seedlings get an early vigorous growth, which often determines the success or failure of the crop. Details of preparation vary, depending on the soil and the previous cropping. Where cover crops are grown, they should be thoroughly disked and plowed under about 6 weeks before tobacco seedlings are transplanted to insure decomposition and pulverization.

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FIGURE 8.—Seedbed at Greeneville, Tennessee, showing tobacco plants of transplanting size. A board supported by the sideboards provides a walkway for drawing the plants and thus prevents walking on plants and spreading soilborne disease organisms. Also shown are the boxes used to transport the plants to the field.

Tobacco is best produced with a controlled nutrient level. Rates of fertilizer applications vary, depending on the tobacco type, the cropping system, amount of manure applied, the soil, and the weather. Fertilizer practices are discussed in the sections on cultural practices for each tobacco type.

The method of fertilizer application is important for the survival and subsequent growth of the tobacco plant. The feeding roots, particularly in the early-growth stages, develop in a limited zone of soil. An ideal distribution is to apply two bands of fertilizer when the seedlings are transplanted. These bands are 3 to 4 inches on either side of the plant and 2 inches below the root zone. In most cases, it is necessary to apply additional fertilizer as a side dressing 2 to 3 weeks after transplanting.

Some transplanting machines are designed to apply fertilizer at the same time the plants are set. Fertilizer is sometimes broadcast when the rate of application is high but this is not recommended because the fertilizer cannot be used efficiently by the tobacco crop.

Sources of nutritive elements in fertilizer mixtures are numerous and varied. The three forms of nitrogen are nitrate, ammonia, and complex organic. Nitrate is the most available form and, at the same time, the most leachable.

If conditions for nitrification are favorable, ammonia is similar to nitrate in its availability to the plants and may be less subject to leaching. The complex organic forms of nitrogen are not immediately available to plants, but are eventually, depending on conditions favoring ammonification and nitrification. They are not readily lost by leaching but cannot be used as insurance against leaching. They are usually more expensive and are not used to any great extent.

Superphosphate, triple superphosphate, and dicalcium phosphate are satisfactory sources of phosphorus. The potassium may be derived from carbonate, sulfate, sulfate of potash-magnesia, nitrate of potash, or in small part from muriate of potash, provided the chlorine content of the mixed fertilizer is held to minimum recommended levels. A limited amount of chlorine is recommended for some types.

Sources of nitrogen, phosphorus, and

potassium in the fertilizer mixture should supply much of the required calcium, magnesium, sulfur, and chlorine. Fertilization with the microelements—boron, copper, manganese, and zinc—is not necessary except where deficiencies are known to exist. Their use when not needed may prove toxic.

Transplanting and Cultivation

Careful and proper setting of tobacco plant roots in the soil is important to early plant growth. Only healthy, well-grown plants of uniform size should be pulled from the seedbed. If the transplants are held for longer than overnight, they should be placed upright in baskets or boxes provided with ample aeration to avoid heating. If the plants are held only overnight, they can be placed in an upright position and packed fairly tight in a box to avoid crooking the stems and the roots. Foliage should be kept dry or plants will heat.

If possible, transplanting should be done on a cloudy or rainy day or in the afternoon and when the temperature is not above 85°F. to avoid excessive wilting. In dry weather, enough water should be added to avoid immediate and excessive wilting. If transplanting is by hand, apply about 1 pint of water per plant. Transplanters can be regulated for varying amounts of water. It requires several days for the plant to recover from the shock of transplanting. As soon as practicable after transplanting, dead plants should be replaced. A good uniform stand is important.

If a modern transplanting machine is used, the distance between plants, amount of water, and packing of soil around the roots can be automatically regulated and adjusted (figs. 9 and 10). As much as 2 to 3 acres can be set in a day with a single row transplanter and double this number with a two-row transplanter. Hand transplanters may give satisfactory results and can be effectively used for planting small acreages.

The hand-setting method, using a dibble, wooden peg, or other suitable device, is practical in all areas to a limited extent. To determine uniform spacing, it is a common practice to mark the points at which the plants are to be set by some simple device, such as a stick with several pegs on it at proper distances apart. The plant is set in a hole 4 to 6 inches deep and the soil firmed around the roots. Unless the soil is already wet, plants should be watered as they are transplanted. Do not cover the terminal bud.

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FIGURE 9.—Transplanting with tractor-drawn equipment. Single-row transplanter used in setting tobacco.

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FIGURE 10.—Transplanting with tractor-drawn equipment. Two-row transplanter used in transplanting tobacco.

The recommended spacing and the usual time of transplanting for the various types of tobacco are given in table 4.

The primary function of cultivation is to keep weeds under control and to aerate the soil when it is compacted by heavy rains. Cultivation should begin as soon as the plants are established, usually 7 to 14 days after transplanting, and

TABLE 4.—*Usual time of transplanting and the spacing in the field for various types of tobacco*

Type and area	Transplanting time	Spacing	
		Between rows	Between plants in row
		inches	*inches*
Flue-cured			
In Florida and Georgia	Mid-March to Mid-April	42 to 48	18 to 24
In South Carolina	Mid-April to mid-May	42 to 48	18 to 24
In North Carolina and Virginia	Mid-April through May	42 to 48	18 to 24
Fire-cured			
In Kentucky and Tennessee	Late May or early June	42	36 to 42
In Virginia	Late May or early June	42	36
Air-cured			
Burley	Mid-May to early June	42 to 45	14 to 18
Maryland	Late May to mid-June	36 to 40	22 to 30
Dark air-cured	Late May to mid-June	42	30 to 36
Filler			
In Pennsylvania	June 1 to June 30	36 to 40	24 to 28
In Ohio	June 1 to June 30	36 to 40	24 to 28
In Puerto Rico	Late October to early January	36 to 42	15 to 18
Binder and sun-grown wrapper			
Connecticut Havana seed	June 1 to June 20	36 to 40	17 to 20
Connecticut Broadleaf	June 1 to June 20	42 to 45	20 to 27
Wisconsin Havana seed	June 10 to June 30	32 to 40	16 to 21
Shade-grown			
In Connecticut	Latter half of May	36 to 40	12 to 15
In Florida and Georgia	Latter half of March	48 to 54	10 to 14
Perique	Latter half of March	60	36 to 42

continue as long as the size of the plants permits.

Tobacco is easily damaged by too much water and in wet areas is usually planted and cultivated on ridged rows. Most types except flue-cured are flat cultivated. However, slight ridges or level cultivation is used where drowning is not a problem . Rows are usually ridged for flue-cured tobacco.

The first cultivation is fairly deep (3 to 4 inches) after which the cultivations are frequent and shallow to maintain a loose, fine mulch about the plants and to control weeds (fig. 11).

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FIGURE 11.—Cultivating tobacco in Georgia.

However, on flue-cured tobacco, usually the second cultivation is also fairly deep and considerable soil is thrown around the plants at the last cultivation. The plants are cultivated three or four times. Listing may be used as an aid to prevent lodging in some areas.

In addition to cultivation, one or two hoeings may be desirable to control weeds and bread the crust around the young plants. Mechanical hoes or other equipment is used where large acreages are involved.

For additional information on weed control see the section on herbicides for weed control.

Topping and Suckering

Tobacco of all domestic types except shade-grown cigar wrapper is normally topped. For burley and Maryland tobaccos, the tops are broken off by hand when the plants begin to flower or when the plants have reached full flower about 2 or 3 weeks before harvest (fig. 12). For flue-cured tobacco, the tops are removed at early to medium flower which is about the time harvest begins. For fire-cured, dark air-cured, and cigar-filled types, the plants may be topped as soon as they have sufficient leaves and before flowering.

The number of leaves left on the plants after

topping depends on the type of tobacco grown, soil fertility, soil moisture, weather, and vigor of the plants. Topped tobacco does not blow over as readily as untopped during windy rainstorms.

The number of leaves left on the stalk partially depends on type. The dark fire-cured types are generally topped to fewer leaves than the flue-cured and burley. If rainfall has been heavy, the tobacco should be topped lower, leaving fewer leaves, than if the weather has been dry. If the soil is extra fertile, tobacco should be topped higher, leaving more leaves, than in poor soil. Also, vigorous plants should be topped higher.

After topping, suckers develop in the leaf axils and should be removed or controlled (fig. 13). If suckers are removed, plants should be suckered at least once for Maryland tobacco and twice for burley and stalk-cut cigar types to obtain higher yields and better quality leaf. For flue-cured tobacco, suckers should be removed at least twice during the season. Fire-cured and dark air-cured types are usually suckered at weekly or 10-day intervals after topping. If possible, suckers should be removed when they are no more than 4

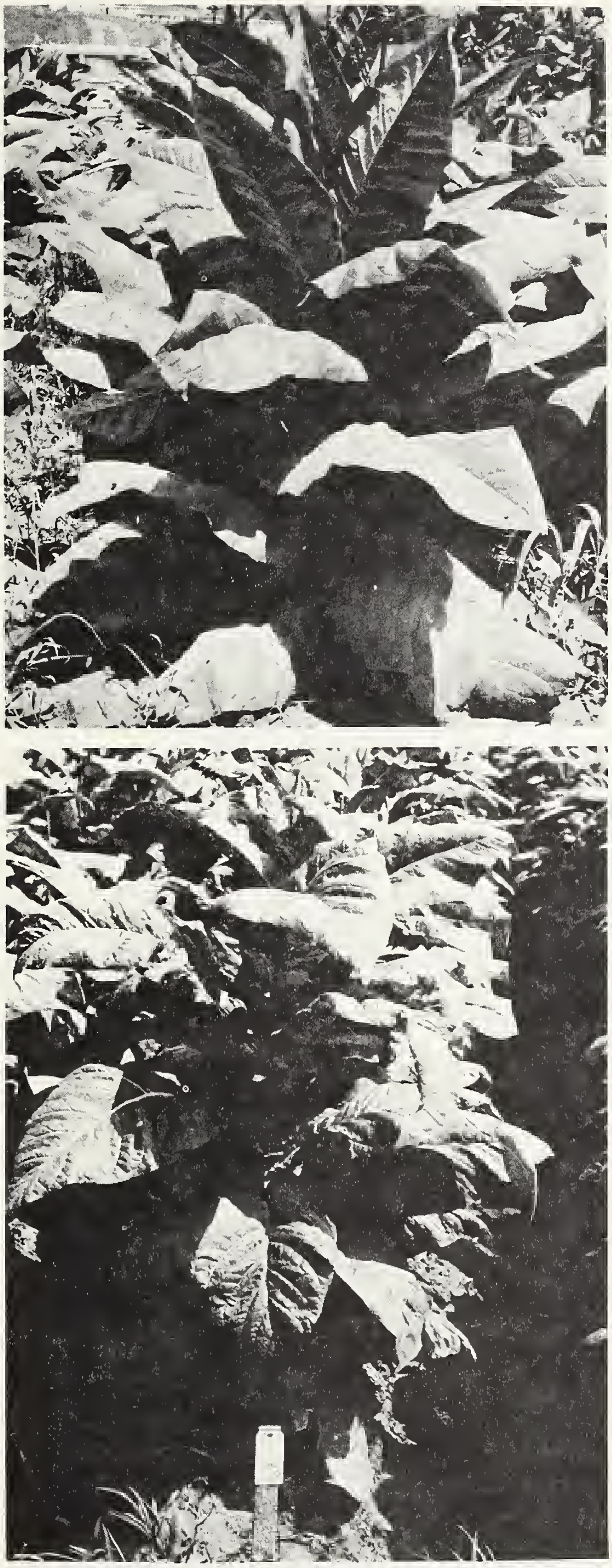

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FIGURE 12.—Maryland variety Catterton not topped (top), and flue-cured variety Hicks Broadleaf after topping (bottom).

PN-4251

FIGURE 13.—Tobacco plant showing the development of leaf axil suckers after topping.

to 5 inches long and before they become so tough that leaves are torn or broken in the process.

To break the suckers off by hand is a time-consuming and laborious operation. Systemic chemicals can be used that suppress the growth of suckers by action within the plant or contact chemicals can be used that kill the small sucker buds outright on contact.

Maleic hydrazide is a systemic growth regulator that is widely used for controlling suckers, especially in areas where flue-cured and burley tobacco are grown. Contact growth regulators that are used for controlling suckers include such fatty alcohols as octanol and decanol on flue-cured tobacco and certain light mineral oils on dark tobacco types.

Maleic hydrazide is applied as a spray at the time of topping. All of the suckers should be removed by hand at the time of application, because the material will not control those already beginning to grow. Maleic hydrazide is a systemic growth regulator and is absorbed into the plant, therefore, it is not necessary to get the material in the axil of the leaves. Best results are obtained when the plants are growing vigorously. This is generally obtained about 2 days after a rain or irrigation.

Methods on how to constantly obtain a high degree of sucker control with contact-type sucker control agents have not been determined. It is necessary that the material come in contact with the small sucker, therefore, the plant must be upright and the material applied in such a way that it will run down the stalk. Two applications are often necessary. Caution should be used in applying contacts as some tobacco types may be more sensitive to these than others.

Many growers are using both contacts and systemic chemicals. The contact is usually applied before topping. In flue-cured this is when approximately 50 percent of the plants are in the button stage. After spraying the plants, they are then topped. If the field is not uniform it may be necessary to spray again in about 5 days. A systemic is then applied about 7 days after the last contact application.

FLUE-CURED TOBACCO

Flue-cured is the most extensively grown type of tobacco. It is a principal constituent of domestic blended cigarettes and the chief type exported. The use of cigarette filters has accentuated the demand for a full-bodied tobacco rich in aroma and flavor. Flue-cured tobacco is also used in smoking mixtures, for chewing tobacco, and for export. The better grades are lemon to orange in color, due largely to the soil on which the tobacco is grown, varieties planted, fertilizer used, and curing procedures.

Flue-cured tobacco is grown in southern Virginia, middle and eastern North Carolina, eastern South Carolina, southeastern Georgia, and northern Florida (fig. 14).

Varieties

Varieties of flue-cured tobacco have probably changed more since 1950 than any other phase of tobacco production. This has been brought about by the development of higher-yielding, disease-resistant varieties. The occurrence and spread of such tobacco diseases and pests as black shank, bacterial wilt, and nematodes in the flue-cured tobacco growing areas have led to the development of resistant varieties.

Most of the flue-cured tobacco varieties may be divided into two general groups according to plant type. They are the narrow leaf, or old type, varieties and the broadleaf varieties. In their

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FIGURE 14.—Flue-cured tobacco in South Carolina.

general growth characteristics, the old type varieties have narrow leaves and produce medium to heavy-bodied cured leaf, which is in demand by both foreign and domestic manufacturers. Most of the broad leaf types have broad leaves that produce cured leaf of light to medium body, which is in demand by domestic manufacturers.

The incorporation of disease resistance into flue-cured tobacco has always been a primary breeding objective in the development of varieties. The basic black shank resistance in most of the presently grown varieties comes from Florida 301, a cigar-wrapper type. However, in recent years three varieties were released in which the black shank resistance was derived from wild species of tobacco. These are NC 2326 with its resistance derived from the wild species *Nicotiana plumbaginifolia* and McNair 20 and McNair 30 with their resistance derived from *Nicotiana longiflora*.

All of the bacterial and fusarium wilt resistance has been derived from T.I. 448A, a noncultivated type of wild tobacco found in South America. The basic root knot resistance presently available came from T.I. 706, a noncultivated type.

The popular old type varieties are Hicks Broadleaf and similar varieties such as White Gold, Coley's Special, and Bell 15. These varieties are not resistant to black shank, bacterial wilt, and root knot. Other varieties that have the same general growth and cured leaf characteristics and are resistant to black shank are NC2326, McNair 20, and McNair 30.

The following varieties have similar leaf shape and growth characteristics as Hicks Broadleaf but the cured tobacco is generally lighter in color and body. These varieties are Coker 319, Virginia 115, Speight G5, Speight G7, and Speight G13. All of these varieties are resistant to black shank and, in addition, Speight G13 is resistant to bacterial wilt.

Varieties that have root knot resistance, in addition to black shank and bacterial and fusarium wilt resistance, are NC 95, Coker 254, Coker 258, Coker 347, Speight G-33, Speight G-41, SC 72, Va 770, NC 88, Speight G-28, McNair 944, and Speight G-15.

Broadleaf varieties that have black shank and varying degrees of bacterial and fusarium wilt resistance are Coker-187-Hicks, Coker 298, Speight G-36, McNair 12, McNair 133, McNair 135, Coker 411, SC 71, McNair 14, and Bell 93. In addition, SC 71, SC 72, and Va 770 have resistance to tobacco mosaic. Growers should select varieties for a particular disease problem.

Soil Selection and Management

Flue-cured tobacco is very sensitive to available nutrient supply and is a hand-fed crop best suited to well-drained soil of low natural fertility and good capacity to hold moisture. The influence of nutrient supply on the chemical and physical properties of flue-cured tobacco and the proportions in which these properties must be contained in the cured leaf make it necessary to keep the nutritional level under close control.

Soil that is too fertile produces tobacco that is generally characterized by being too large, too green, and with a failure to ripen properly. It cures to a dark color or is trashy and the chemical constituents of the leaf are out of balance. However, if the soil is too poor, little growth will take place. The ideal soil is poor enough so that nutrients can be added in just the right amounts.

A rather wide range of soils, most of which are sandy loam and suitable for growing flue-cured tobacco, is found in the Piedmont and Coastal Plain regions of the southeastern United States. These soils are underlain by varying mixtures of gravel, loose sand, sandy clay, and sometimes even clay subsoil.

Extremely porous gravel or sandy subsoils are undesirable for growing flue-cured tobacco because they leach during wet weather and dry out during dry weather. On the other hand, hard subsoils drain poorly, and heavy rainfall may drown the crop.

The rotation of flue-cured tobacco with other crops is desireable when good tobacco land is available and especially if tobacco diseases are a problem. Where adapted, small grains and grass crops, particularly oats and Ky 31 fescue, are suitable to precede flue-cured tobacco. A small-grain cover crop protects the soil from wind and water erosion during winter without favoring tobacco diseases.

Fescue seeded with small grain is a grass cover crop that may be allowed to grow for one or more years and is resistant to tobacco diseases. Heavy fescue sod tends to choke out undesirable weeds. However, fescue sod is hard to break up

and may present problems in preparing the soil for transplanting.

The use of legumes in rotation with flue-cured tobacco is not recommended because legumes produce nitrogen and may deposit too much in the soil, especially if the legume immediately precedes the tobacco. Also, most commonly grown legumes are hosts for nematode and disease problems.

Fertilization

Flue-cured tobacco is grown on relatively infertile loam soils and needs a complete fertilizer. The ratio of nutrients combined in commercial tobacco fertilizer is fairly well established but the rate of application will vary with soil fertility. Table 5 shows the range of fertilizer constituents recommended per acre.

The rates of plant material needed per acre recommended in table 5 may be obtained by varying the rate of application or formula used so as to control nitrogen, phosphorous, and potash in rations of 1-2-3 or 1-3-3. Complete fertilizer in 1-2-3 ratios such as 4-8-12, 5-10-15, 6-12-18, or 8-16-24 are best because the extra phosphorous is not necessary on most tobacco soils.

The complete fertilizer should contain at least 50 percent of the nitrogen in the nitrate form and the sidedressing should contain no phosphorous. There is no response from phosphorous in sidedressing although many growers use complete fertilizers for sidedressings by splitting the applications. Most sidedressing materials are 8-0-24, 13-0-44, or 15-0-14. Where potash is low the 15-0-14 will not supply enough potash in relationship to the nitrogen.

TABLE 5.—*Ranges of fertilizer constituents recommended per acre*

Constituent	Minimum pounds per acre	Maximum pounds per acre
Nitrogen	40[1]	75[1]
Phosphorus	70	120
Potassium	100	160
Chlorine	20	30
Calcium	60	pH 6.2
Magnesium	30[2]	pH 6.2
Sulfur	75	200
Trace elements	Only when needed	

[1]50 percent in nitrate form

[2]One-half should be water soluble.

In many instances, and particularly where adequate moisture is not available immediately after transplanting, fertilizer that comes in contact with the roots of newly set plants will damage or kill the plants. Fertilizer can be applied in two bands by machines 7 to 8 inches apart at a depth slightly below the root crown of the seedling. This will greatly reduce the risk of fertilizer injury.

Nutrient requirements of the tobacco plant, other than nitrogen and potash, can be met by preplant applications. However, since nitrogen and potash may be leached by excessive water, additional applications of these nutrients may be needed. About one-half to three-fourths of the total amount is applied before planting with the balance as a sidedressing. When inadequate preplant applications are made or leaching occurs, supplemental applications to bring the supply back to normal should be made as soon as the deficiencies are known. A soil test should be made and the recommendations of a County Extension Specialist followed if excessive leaching rains have occurred.

Topping, Suckering, and Harvesting

Topping increases the thickness of the leaves left on the plant and improves their quality. The number of leaves left on the plant, usually from 16 to 24, depends on the variety of tobacco and vigor of the individual plant. More leaves are left on vigorous plants.

After topping, suckers or buds grow at the base of each leaf. These must be broken out by hand or controlled by chemicals for full development of the leaves.

Flue-cured tobacco is ripe when the green leaves begin to fade and become a dull, yellowish-green color with a cream-colored tip. As the leaves ripen, they are broken off (primed or picked) in lots of three to five at each priming, beginning at the bottom of the plant. Normally, primings are made at weekly intervals, requiring from 4 to 6 weeks to harvest an entire crop.

The usual procedure in priming leaves is for

the primers to walk along the rows and pick the leaves by hand, but this method is laborious and expensive. To reduce the labor, machines can be used on which the primers ride while picking the tobacco (figs, 15 and 16). Mechanical harvesters are gaining in popularity in the flue-cured area. Where mechanical harvesters are used, the leaves are harvested with a machine, which eliminates the primers.

Most flue-cured tobacco is prepared for curing by hanging the leaves on 54-inch sticks, Thirty to 34 bundles of three leaves each are tied with three-to four-ply cotton twine to each stick. The first bundle is attached 6 inches from one end of the stick, and the others are tied on alternate sides of the stick with a half-hitch loop to within 6 inches of the other end where the twine is broken and tied off. Sticks are hung horizontally and spaced about 10 inches apart on tiers in curing barns. This hand operation is still a common method of arranging the leaves for curing.

To reduce labor costs, several machines for attaching the leaves to the stick are available. A popular one is a sewing device that stitches two layers of leaves together, with the stick between the layers (fig. 17).

Flue-cured tobacco also may be bulk cured. For bulk curing, the primed leaves are placed between two wood or metal strips and tightly pressed into bundles varying from 75 to 125 pounds green weight (fig. 18). These bundles are tightly pressed together and hung on tiers in especially constructed curing barns. Bulk barns must be used when tobacco is mechanically harvested.

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FIGURE 15.—Harvesting flue-cured tobacco with the use of a mechanical harvesting aid.

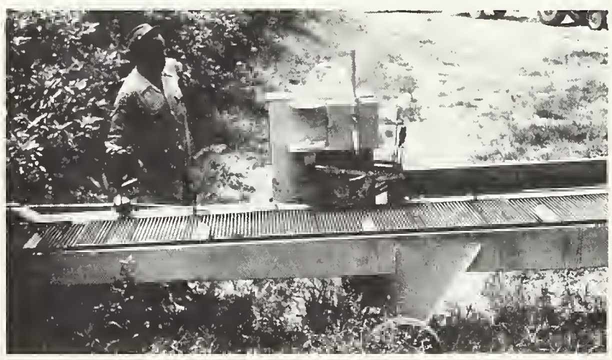
PN-4254

FIGURE 16.—Harvesting flue-cured tobacco by the picking or priming method using a tractor-driven harvesting aid.

Curing

Flue-curing is a term that describes the heating system used in early curing barns. This method of using flues for curing has almost disappeared.

Oil and gas-burning heating systems are presently used. Some of these systems do not have flues to discharge combustion fumes to the outside and when they fail to operate properly there is danger of contaminating the cured leaf with odors and smoke from oil.



PN-4255

FIGURE 17.—A machine used to tie the primed tobacco leaves on sticks in preparation for hanging in the barn.

PN-4256

FIGURE 18.—Tobacco in a bulk curing barn ready for curing.

Barns and fuel

Many materials are used for barn construction. Most barns have wooden frames. The sides can be made of two layers of 1-inch boards with building felt between them. Other types of construction can be a layer of wood and a layer of metal siding with building felt between them or combinations of fiber board, gypsum board, asbestos board, and metal. Walls also can be made of all concrete or tile. The most common construction is the wooden-frame type with a layer of building felt between two 1-inch layers of wood siding (fig. 19).

Dimensions of conventional curing barns are standardized to provide horizontal spacing of tiers 48 inches apart on center. The length of the tiers does not matter but the most efficient heat distribution and ventilation is obtained in square barns. Barns with outside dimensions of 17 or 21 feet are the types usually built. The lower row of tiers is placed approximately 6 feet above the ground with a 2-foot vertical distance between tiers.

Curing barns are used about 6 weeks each year, which makes the value of insulating side walls economically questionable. However, these walls should be without air leaks. Controllable openings in the roof and foundation are necessary to stop air movement during yellowing and permit air movement through the leaf during drying. Openings in the roof are usually located along the ridge line and those in the foundation are just above ground level.

The many types of heating units are all designed to reduce the amount of personal attention necessary during curing (fig. 20). Oil and gas are the principal fuels used.

Some units use gravity-fed liquid fuels and have no temperature control; others have automatic devices that control temperatures at fixed settings and invrease temperatures at predetermined rates and time intervals.

Several types of open-flame thermostatically controlled gas burners are being used. All such burners are equipped with metal baffles above the flame as a safety precaution; they differ mainly in design and arrangement of combustion units.

Numerous types of oil burners are used including open-flame wick, closed pot, and open and closed pressure-gun systems. Open-flame burners that release the combustion gases within the barn are the most economical; however, if they do not operate properly, the tobacco may be damaged with smoke or oil fumes.

A different type of barn called a bulk barn has been gaining in popularity. Bulk barns are especially constructed and are purchased pre-built from the manufacturer. In these barns, the curing temperature and humidity are the same as in conventional barns but air is circulated by a fan through a system of ducts and plenum chambers rather than by natural movement.

Conditions affecting cure

No one set of rules for heat and humidity changes can be used as a standard for curing tobacco. Such curing conditions as amount of heat used, length of curing time, and ventilation, are determined by differences in the leaf at harvest. Leaf differences are caused by differences in varieties, soils, rate of fertilization, stalk positions at harvest, and weather conditions just prior to harvest. Too much fertilizer generally causes a leaf to be larger and greener, therefore, yellowing time and curing time is longer. If tobacco is harvested during wet weather, there is considerably more moisture to

PN-4257

FIGURE 19.—Barn used for flue-curing of tobacco.

get rid of and the ventilators must be opened wider. If it is hot and dry, the cure will be more rapid. Normally, the lower leaves of the plant are thinner and cure faster than the upper leaves. Any conditions that bring about differences in leaf character must be taken into account when curing.

Changes in composition and properties of leaf

The color of flue-cured tobacco is important in determining its value. The plant nutrient supply must be controlled so that at the end of the growing season the plant will lose its vigor and take on a dull yellowish-green appearance, indicating that normal breakdown of the leaf has begun.

When the leaves are removed from the stalk and placed in the warm humid atmosphere of the curing barn, this breakdown is speeded up. Color changes follow a sequence of green to yellow to orange and chemical changes accompany these color changes.

The function of the flue-curing process is to dehydrate the leaf rapidly, after all green has disappeared but before drying begins.

Management during curing

Temperature and humidity schedules generally follow the same time pattern for all flue-curing in both conventional and bulk barns. Time is important and all tobacco cured together in one barn should be harvested the same day. Curing is started immediately after the tobacco is harvested. All ventilators are closed and the temperature is raised to 5° to 10°F. above maximum outside readings. These conditions are maintained until yellowing is well underway, which usually takes from 12 to 24 hours. Slow drying is then started by partially opening the ventilators about one-third to one-half and increasing the temperature at a rate of 1° to 2° F. per hour to 120°F.

After 24 to 48 hours, from the time the tobacco was placed in the barn, yellowing should be complete and the leaves fully wilted and beginning to dry at the tips. Any temperature or humidity condition that kills or dries the leaf before yellowing is complete may seriously damage or destroy the quality of the tobacco. Safe temperatures are about 100°F. the first 24 hours of curing, 110° the next 24 hours, and 120° after 48 hours.

The second stage of curing is one of drying the leaf rapidly enough to fix the yellow color before it degenerates into a brown. To do this, ventilators are opened both bottom and top to provide considerable movement of air which is required to rapidly evaporate moisture at temperatures below 140°F. Higher temperatures before the leaf is dry scalds, or cooks, the leaf, giving it a dark brown or black color.

PN-4258

FIGURE 20.—Interior of a common type flue-cured tobacco barn used for curing. Note the tobacco hanging on sticks from tiers and the gas-type burner used for heat.

After the leaf has dried, there is no danger of scalding. The stems are dried by partially closing the ventilators about one-third to one-half and increasing the temperature to 165° or 170°F. at a rate of 5° per hour. During the last few hours of the stem-drying stage, ventilators may be closed completely. Temperatures higher than 170° F. often scorch the leaves which gives the tobacco an undesirable reddish color and a toast-like odor. If the air movement is controlled by ventilators to just the amount needed for proper drying throughout the curing process, fuel efficiency will be increased.

At the end of curing, and before being stored, the dry and brittle leaf must absorb enough moisture so it can be handled without breaking, a condition known as case, or order. Normally, if ventilators and barn doors are opened and the leaf is exposed to the moist night air for one night after the fire has been put out, sufficient moisture will be provided. When the humidity is low, sprinkling barn floors with water may be necessary. The leaf should not be allowed to absorb too much moisture or molds will cause damage in storage.

Sorting and preparing for market

The cured leaf is stored in the barn in piles 4 to 6 feet high with the sticks placed one on the other like shingles on a roof. Length of storage normally is from 2 to 6 weeks, during which time most of the light green color disappears, colors darken, and aromas become more mellow and attractive. After storage, bulk-cured tobacco is generally put in burlap sheets and gotten ready for market as soon as it is taken out of the barn.

In preparing the leaves of stick-cured tobacco for market, they are removed from the stick and sorted into grades; each priming is handled separately. When the tobacco is bulk-cured, it is generally taken from the racks and put on a burlap sheet ready for market. The number of grades will vary but normally two grades per priming are enough.

Farm grades are based on color, thickness, length, grain, roughness, elasticity, and the percentage of physical imperfections. Leaves from the various positions on the stalk fall into different grades (fig. 21). Bottom leaves, which are usually thin and smooth, fall into grades designated as primings. If these lower leaves have some thickness and porosity, they fall into lug grades.

PN-4259

FIGURE 21.—Approximate division of leaves used for the flue-cured grades: Lugs, cutters, and leaf.

Leaves from the third and fourth priming are normally large and thin and have considerable grain and oil, and are relatively free of physical imperfections. These leaves fall into the cutter grades.

Leaves usually become thicker above the midstalk. Grades from these upper stalk positions are known as leaf or smoking leaf. If they are completely ripe, they are classified as smoking leaf.

PN-4260

FIGURE 22.—Tobacco ready for sale.

All grade groups have many subdivisions based on color, length, percentage of mixture with other grades, width of leaf, degree of physical damage, and other factors.

Practically all flue-cured tobacco is sold loose leaf (fig.22). To make the tobacco attractive for sale, lot sizes are limited to 200 pounds and the leaves should be sound, cleanly graded, free of trash and dirt, and attractively arranged.

FIRE-CURED TOBACCO

Fire-cured tobacco is characterized by a distinct aroma of wood smoke from the open fires used in curing. It may vary from light to dark brown in color and have a thin to heavy body, as shown in table 6.

It is used for snuff, plug, smoking, twist, and wrapper tobacco, and to a limited extent, for cigars and cigarettes. Most of the fire-cured tobacco is grown in central Virginia, western Kentucky, and northern Tennessee.

The varieties of tobacco used for fire-cured and dark air-cured leaf, Types 21, 22, 23, 35, 36 and 37 are described in the following list.

Ky 171.—Resistant to Wildfire, Tobacco Mosaic, and Black Root Rot. Used principally as fire-cured type 22 and 23, but may be used for type 36 because of its root rot resistance. Suitable for domestic and export. Best for export "cutting." This variety is a recent release, but is rapidly gaining popularity in Kentucky and Tennessee.

TABLE 6.—*Elements of quality and degrees of each element for Kentucky and Tennessee fire-cured tobacco, types 22 and 23*

Tobacco attributes or characteristics which constitute quality are designated as elements of quality. The range within each element is expressed by words or terms designated as degrees. These degrees are arranged to show their relative value and are used in determining the quality of tobacco. The actual value of each degree varies with group.

ELEMENTS	DEGREES		
Body	Thin	Medium	Heavy
Maturity	Immature	Mature	Ripe
Leaf Structure	Close	Firm	Open
Oil	Lean	Oily	Rich
Elasticity	Inelastic	Semielastic	Elastic
Strength	Weak	Normal	Strong
Finish	Dull	Clear	Bright
Color Intensity	Pale	Moderate	Deep
Width	Narrow	Normal	Spready
Uniformity	Expressed in percentages		
Injury Tolerance	Expressed in percentages		

Ky 151.—Resistant to Tobacco Mosaic. Used as types 22, 23, and 36. Best as fire-cured type 22 and 23. Produced mostly for domestic use.

Walkers Broadleaf, Orinoco, Lizzard Tail, Brownleaf, and Virginia 331.—These varieties do not have disease resistance. They are grown primarily in Virginia for type 21 trade. A small amount is also grown in Tennessee.

DF-300.—Some resistance to black shank; no other resistances. Grown mostly in Tennessee for both type 22 and 23. It is suitable for snuff or wrapper tobacco.

Little Crittenden.—Has no disease resistance. Used mostly for type 22 and 23, but is excellent as air cured type 36. Domestic use for snuff, chewing, filler, and pipe.

Black Mammoth.—Has no disease resistance. Used mostly as fire-cured type 22 and 23. Some grown for type 36. Used mostly for domestic consumption.

Little Wood (Green Wood).—Has no disease resistance. Primarily produced for type 22, 23 and 36. A heavy bodied tobacco used mostly for domestic consumption.

Mosaic Resistant.—Little Crittenden, Black Mammoth, Madole, and Little Wood. These are the same as those above except they have mosaic resistance. The mosaic resistant varieties were developed by cooperative work of the Kentucky Agricultural Experiment Station and the U.S. Department of Agriculture, Agricultural Research Service.

Ky 160.—A tobacco mosaic resistant, dark air cured, one sucker variety, type 35. It is used for snuff, chewing, pipe, and export.

Ky 165.—A dark air-cured variety, type 35, resistant to tobacco mosaic, black root rot, wildfire, and fusarium wilt. The uses are the same as KY 160.

Little Sweet Orinoco.—A dark air-cured variety, type 35, has no disease resistance, but on

relatively disease-free land is a good variety. The uses are the same as KY 160.

Soil Selection, Fertilization, and Preparation

Fire-cured tobacco is produced on soils varying from heavy-silt loams to silty-clay loams. Good internal drainage is essential to growth. Fire-cured tobacco is usually grown in rotation with other crops and following a grass-legume sod mixture. The type of sod mixture is not as important as a good, healthy sod to turn under.

Plowing should be in late February or early March to allow the vegetative matter to decompose before the land is prepared for transplanting the tobacco plants. Fertilizer mixtures in a 1-1-1, 1-2-2, or 1-2-3 ratio with potash in the sulfate form may be used depending on soil tests. The 1-1-1 ratio is adapted to the production of the thick leaf desired for snuff, while the 1-2-2 and the 1-2-3 ratio is useful where a thinner leaf is desired for the "cutting" trade. The pounds of fertilizer should be decided by the grower and the soil test service used. The testing service may be the county agent's office, a State central laboratory, or the service organization of a fertilizer manufacturer or distributor.

Stable manure is often used to furnish part of the plant nutrients. Because of the danger of chlorine injury to the leaf, the application of manure should not be more than 10 tons per acre. It may be applied and turned under at plowing after mid-March. If plowing is done earlier, the manure should be applied some time after plowing and immediately disked into the soil. Manure turned under in February or early March will lose considerable nitrogen due to leaching. The land should be further prepared by disking. Then use a drag to level and firm the soil before plants are set. After the plants are set, cultivation should be used to keep down weed growth. During cultivation, root pruning should be avoided since it will slow, or in cases of severe pruning, may reduce total plant growth.

Transplanting

Fire-cured and dark air-cured tobacco plants were once transplanted in checks 3 1/2 feet apart each way so that they could be cultivated in two directions. With this spacing, machine transplanting was little used. Now transplanting is almost all with machines. The plants are set 36 inches apart in the row with the rows 40 to 42 inches apart. The distance between rows is largely a matter of grower preference.

Topping and Harvesting

Topping is removing the bud by breaking it out and usually is done as soon as the plant has 12 to 16 leaves. This forces the leaves to grow larger, thicker, and darker (fig. 23). Low, early topping causes suckers to grow. These suckers must be removed, by breaking out or cutting as often as they appear, usually at weekly intervals. Sucker growth may be prevented by the use of chemical inhibitors.

When mature, the leaves are thick and heavy and are mottled yellow and green. Maturity is commonly reached 30 to 40 days after topping. Gum accumulates on the leaves in dry weather during the interval between topping and harvest. Its presence improves the quality of the leaf. Gum is washed from plants by heavy or prolonged rains. If such rains occur near harvest, harvesting should be delayed at least 2 or 3 days to allow more gum to accumulate.

The entire plant is harvested by cutting the stalk near the ground level. As the plants are cut, they are speared at once through the stalk about 10 inches from the base onto a 4-1/2-foot stick, one end of which is forced into the ground at an angle. The number of plants placed on each stick varies from five to six, depending on the size of the individual plant. The sticks bearing the plants are left in the field until the leaves are well wilted. Allowing the plants to wilt in the field reduces breakage of leaves in the barn and speeds curing.

Barn Construction

The old-type barn used for fire-curing is built of logs. These barns are small and generally high enough to hold five sets of tier poles.

The new-type fire-curing barn is a much larger, more modern, frame building. These barns are generally about 20 feet wide, 48 feet in length, and 20 feet to the eaves. When size varies from this, changes in width would be in increments of 4 feet and in length by increments of 12 feet. Figure 24 shows a new type barn used widely in Kentucky and Tennessee. The ven-

PN-4261

FIGURE 23.—Low topping and close suckering of plants that are typical of fire-cured tobacco.

PN-4262

FIGURE 24.—Type of barn used in fire-cured districts of Kentucky and Tennessee. The fire-cured leaf is hanging in barn with remnants of fire on the ground.

tilators along the ridge of the barn and along the sides in or at the foundation are used to control heat and humidity in the structure during curing.

Other than the ventilators, the barn should be made as nearly air tight as possible. Better all-round curing conditions are obtained if the barn is located in a wooded area where temperature and humidity will not fluctuate as much as in the open.

Curing

The smoke from open hardwood fires gives a characteristic, wood smoke odor and taste to fire-cured tobacco and improves its keeping qualities. Hardwood and hardwood sawdust are both used as the fuel supply.

To avoid drying the leaf too rapidly, no heat normally is used during the first stages of yellowing fire-cured tobacco. Curing should be gradual to allow proper colors,(yellow and then deep brown) to develop in the leaf. For good yellowing, temperatures should not be higher than 75 to 80° F. with 80 to 85 percent relative humidity. Usually 3 to 5 days after the tobacco is put in the barn, slow fires are started on the dirt floor to aid yellowing. However, if weather conditions provide the above temperature and humidity in the barn, yellowing without heat is advisable. During cool, damp weather very small fires may be necessary to produce proper yellowing in the leaf. During warm, wet weather small fires may be needed to prevent house-burn or rotting of the leaf.

When brown spots begin to appear on most of the leaves, yellowing is about complete and the temperature can be increased to 80 to 90 degrees F. with a relative humidity of 85 ot 90 percent. These conditions should be held until a clear solid brown color is obtained. When the leaves on the bottom tiers have turned brown, the relative humidity may be reduced to 78 to 80 percent by increasing ventilation or temperature, or both. At no time should the temperature in the barn exceed 100°F.

When the leaf blade and mid-vein are a uniform brown, the leaf may be finished by using temperatures of 80 to 85°F. and a large amount of smoke. The smoke is produced by banking the fires with wet sawdust. During this period of curing, the barn floor and sawdust are usually kept wet. In order to produce as much smoke as possible without undue heat, the fires are kept low. If the tobacco becomes brittle, the fires should be stopped and the leaf allowed to become pliable again. When this is accomplished, the fires are again started and the smoking process is repeated until the desired finish is obtained.

When curing is completed, slow fires should be started during wet weather to prevent mold damage and further darkening of the leaf.

Stripping and Sorting

Fire-cured tobacco is thorougly cured by late fall or early winter. When it has become pliable from the absorption of moisture during damp weather, the tobacco stalks are removed from

the sticks. The leaves are then stripped from the stalks, sorted by groups, and neatly tied into graded hands.

There are three principal groups of dark tobacco:

Trash—The thin, small, unsound leaves from the bottom of the plant.

Lugs—Thin leaves, fairly sound, and of good size, but lacking in body.

Leaf—Large, heavy-bodied, sound leaves. The leaf group usually comprises 60 to 80 percent of the crop.

A sub-group of leaf is the "tip." These are leaves that are under 16 inches long, size 43. These short leaves should always be separated from the other leaf grades.

At the end of the day's stripping, the hands of tobacco should be bulked by grade to keep them in good condition for sale. The bulk is usually made on a clean flat surface in the barn. It is built up by placing the hands individually across the length of the bulk, repeating this procedure layer by layer until all hands are in the bulk. The size of the bulk, particularly its length, will depend on the amount of a particular grade the grower estimates he will have.

When hands of fire-cured tobacco are bulked in proper condition with enough moisture so they can be handled without shattering but not enough to make them feel wet, they will keep indefinitely.

The better grades of fire-cured tobacco are used in the manufacture of snuff, chewing, and smoking tobacco. Each group is subdivided into grades on the basis of size, body, and color of leaf. Leaves from 17 inches to not over 28 inches in length are the most desirable. After grading, the tobacco is tied by grade into neat hands containing six to eight leaves. The tie is made by wrapping a leaf of equal quality tobacco tightly around the base of the hand starting with the tip of the tie-leaf. The stem end of the tie-leaf is drawn through the hand to secure the tie.

AIR-CURED TOBACCO

Air-cured tobacco includes nearly all the cigar types, burley, dark air-cured, the Maryland type, and the Virginia sun-cured types. Tobacco for air curing is placed in the barn when it is ripe, usually when it has wilted. Curing is controlled by regulating the ventilation of the building. Except for cigar-wrapper types and occasional leaves taken from burley, the leaves are left on the stalk during curing. Supplementary heat is used in curing only to prevent decay during prolonged wet weather.

A discussion of air-cured varieties, culture, and harvesting follows. Barn construction and curing are similar for all air-cured tobacco and are discussed in a separate subsection later.

Burley Tobacco

Burley tobacco is a light air-cured type. The appearance of the burley plant is different from other tobacco; its stalk and leaf midrib are light green to creamy colored and its leaves are light green (fig. 25). As maturity approaches, the leaves develop a light, yellowish green appearance, beginning at the bottom of the plant.

The leaf is fine textured, porous, low in gum, light bodied, and straw to brown colored when properly cured. Burley is used in the manufacture of cigarette blends, pipe-smoking mixtures, and chewing tobacco.

Most burley is grown in the blue-grass region of central Kentucky. The largest acreages outside of Kentucky are in Tennessee, Virginia, western North Carolina, and Ohio.

PN-4263

FIGURE 25.—Field of Burley tobacco in Tennessee; curing barn in background.

Varieties

Burley 21 is an easy variety to grow. It produces large yields of high quality leaf and is resistant to wildfire and tobacco mosaic. It has moderate resistance to black root rot.

Burley 11A and Burley 11B are resistant to black shank and fusarium wilt but Burley 37 is a more desirable burley-type with resistance to wild-fire as well as black shank. Burley 49 and Burley 64 are resistant to black shank, wildfire, mosaic, and black root-rot. In general, the varieties resistant to black shank do not produce as good quality tobacco as Burley 21 but they must be grown on land where black shank is a problem.

Higher- yielding varieties have become increasingly popular. Ky 9 and Ky 10 are high-yielding varieties that are grown extensively. Ky 12 is high yielding and resistant to wildfire, fusarium wilt, tobacco mosaic, and black root-rot. Ky 14 is also high yielding and resistant to wildfire, tobacco mosaic, fusarium wilt, and black root-rot. Va 509 is resistant to black shank, wildfire, and black root-rot.

More recently burley hybrids have become popular. The most successful hybrids are male sterile Burley 21 X Ky 10 and male sterile Burley 21 X Ky 12. Other hybrids that are being grown on land with the black shank disease are male sterile Burley 21 X L-8, male sterile Ky 12 X L-8, and male sterile L-8 X Burley 37. These hybrids are resistant to race 0 of the black shank fungus only. They are not resistant to race 1, which is becoming more serious in the burley area.

Soil selection and management

Burley tobacco is grown largely on farms in combination with livestock. Pasture usually occupies most of the farm acreage and tobacco only a small part. This makes it possible for the grower to select the best land for tobacco, and by using manure and fertilizer, assure the higest returns. Tobacco should not be grown on the same area year after year because this destroys tilth and fertility and helps build up such tobacco diseases as black root rot, fusarium wilt, and black shank.

Burley is grown principally on silt loam soils of limestone origin. The soils on which burley is grown often lack good drainage and must be drained by ditching or underground tile.

Burley tobacco grows best on virgin soil or after a heavy bluegrass sod that has been standing for 6 or more years. Ky 31 fescue sods also give good results, and in many areas, are more common than bluegrass. Sod supplies organic matter that improves soil tilth and physical condition.

Some farmers grow burley tobacco in continuous culture, using a legume or small grain cover crop during the winter, or they grow tobacco in 1-or 2-year rotations with other commercial crops, using black root rot resistant varieties. These practices often produce poor-quality leaf and cause erosion as well as a gradual decline in soil tilth. Black shank is common in the burley area and often causes serious losses where continuous culture or short rotations are used, even when resistant varieties are grown.

Fertilizers

The use of fertilizer for burley varies, depending on the soil, cropping system, amount of manure used, and the weather. The sources of nitrogen, phosphoric acid, and potash are largely determined by their availability to the tobacco plant and the cost.

The inorganic forms of nitrogen are satisfactory for burley. Phosphoric acid usually comes from superphosphate and triple superphosphate. Potash may come from any available source, provided it is relatively free of chlorine. Sulfate of potash is widely used and nitrate of potash is also satisfactory, particularly on soils high in phosphorus.

Fertilizer grades recommended by extension tobacco specialists in the burley area usually are 5-10-5, 5-10-10, 6-6-18, 8-8-8, and 12-12-12 but these change from time to time. Side or top dressings of 8-0-24 are also recommended in some States. The soils should be tested by the county agent before fertilizer is applied.

Too much nitrogen does not darken the cured leaf of burley as much as it darkens flue-cured leaf. However, nitrogen rates should be held to the minimum needed for a profitable yield of tobacco that has the quality and nicotine content acceptable to the manufacturers. The total amount of nitrogen available should be about 120 to 160 pounds per acre from all sources. About 50 pounds of nitrogen can be supplied by turning under a good growth of a leguminous cover crop, such as vetch or crimson clover, or by the addition of 10 tons of farm manure.

Phosphoric acid requirements are high on low-phosphate soils typical of most of the burley area. However, on the high-phosphate soils found in some areas of the bluegrass regions of central Kentucky and middle Tennessee, phosphoric acid does not always produce good growth. Figure 26 shows the effects of low phosphorus. Low-phosphate soils should receive 100 to 150 pounds of phosphorus per acre.

The silt loam soils on which burley tobacco is produced usually contain considerable potash that often is not available to the tobacco plant. This potash unavailability is more acute in soils of poor physical condition and is often aggravated by continuous cropping of tobacco or alfalfa.

When tobacco is grown after old bluegrass sod or after heavy manure applications, there will be enough potash for a good crop. The amount of potash to be used depends on the cropping history and quantity of farm manure used and may range from 120 to 300 pounds per acre. Muriate of potash is not recommended as a source of potash.

The amount and sources of calcium, magnesium, and sulfur for best results in growing burley tobacco are not known. However, materials used in mixing fertilizers that supply nitrogen, phosphoric acid, and potash commonly furnish enough of these elements. To date, it appears that the micronutrients—boron, copper, manganese, zinc, and molybdenum—are not needed in burley tobacco fertilizers.

Burley tobacco soils should be limed if they are too acid. A soil test is the most satisfactory way to determine lime needs. Tobacco soils should be limed at least 6 months before transplanting and the pH adjusted to a range of 5.5 to 6.5. If the pH is 5 or below, the crop is likely

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FIGURE 26.—Burley tobacco showing the effects of phosphorus in promoting growth and maturity. Left: without P205 fertilizer; right: grown with 120 lbs/A.

to be damaged by manganese toxicity. On the other hand, if the soil is limed to the neutral point of pH 7 or above, plant uptake of potash may be restricted, which will lower the quality of the tobacco.

Topping and harvesting

Burley tobacco is topped after the plant is in flower. The top is broken or cut off and, as a rule, 18 to 22 leaves are left on the plant. Topping stimulates active development of suckers which must be removed. The number of leaves left on the plant depends on the variety grown, soil fertility, vigor of the plant, and the weather. If the plant is growing vigorously, a grower should top high, leaving as many leaves on the stalk as possible. If a plant is not growing too vigorously, he should top low so there will be enough nutrients to fill out the leaves left on the plant. Dry weather makes a less vigorous plant.

The plants should reach maturity before harvesting, which is usually about 3 to 4 weeks after topping. At maturity, plants become a lighter shade of green and by experience the grower learns when to harvest. The entire plant is harvested by cutting the stalk as near the ground as possible to save the lower leaves. The best cigarette grades are usually found among the lower and middle leaves.

As the plants are cut, they are at once speared onto a stick, one end of which is forced into the ground at an angle, often in such a position that it rests on the stubble of a cut plant (fig. 27). A removable, metal spearhead sharpened to a fine point is attached to the end of the stick and the plants are forced over it onto the stick. Five to six plants are placed on each 4-1/2-foot stick, depending on the size of the plants. The sticks bearing the plants are left in the field until the leaves have wilted. Usually they are not left out overnight.

When the temperature is above 90° F. on a sunny day, the cut tobacco must be moved to the curing barn as soon as the leaves wilt to avoid

PN-4265

FIGURE 27.—After cutting, burley tobacco is speared onto a stick, one end of which is forced into the ground. Wilting is hastened by this exposure.

sunburning. The harvested tobacco should not remain in the field overnight because of possible rain damage. Rain may wash soil onto the leaves causing the tobacco to be of low quality and in some cases unsalable.

In general the bottom leaves on burley tend to burn before it is cut. If these leaves are primed off early, they may bring a better price. Usually, only one or two primings are profitable before the stalk is cut.

Maryland Tobacco

Maryland tobacco is grown in the southern counties of the State. It is a minor type in number of pounds produced but it occupies a favorable export position. The principal use is for blended cigarettes.

Good grades of Maryland leaf are thin and of good length; light in body and color; of a dry, chaffy character; low in alkaloids and have good burning qualities.

Varieties

Maryland varieties are broadly divided into two groups, narrowleaf and broadleaf, but there are numerous intermediate varieties.

The numerous strains, or subvarieties, usually bear the name of some local grower. Among the popular varieties are Wilson, a broadleaf type, and Catterton, a medium broadleaf. Other varieties are Maryland 59 and 609, which are black shank resistant, and Maryland 10, which is a Catterton type resistant to tobacco mosaic. New varieties recently developed and released are: Maryland 64, Maryland 201, and Maryland 872.

Soil selection and management

Maryland tobacco is preferably grown on sandy loam, fine sandy loam, and very fine sandy loam soils. Sometimes fairly heavy loams are used, but such soils do not produce the best quality leaf. The best soils are light brown, loamy sand or light sandy loam to a depth of 8 to 12 inches, with a yellowish or reddish brown, crumbly, sandy clay or heavy, sandy loam subsoil that affords good but not excessive drainage.

Where the subsoil is derived from green sand, it has a greenish tinge. The mineral green sand is rich in potash and some other elements needed for the growth of tobacco.

When tobacco is grown continuously for several years on locations that give profitable returns, a fall seeding of wheat or a combination of wheat and hairy vetch is generally grown as a winter cover crop. Where sufficient suitable land is available, tobacco should not be grown continuously on the same soil. This practice often destroys soil tilth, exhausts soil fertility, and builds up parasites that may damage or destroy the crop.

If pasture and hay are grown for livestock production, a 2- or 4-year rotation can be set up with tobacco following wheat, grasses, and legumes. Otherwise, a 2- or 4-year rotation with commercial crops may be followed. Tobacco also does especially well on land that has developed a growth of natural vegetation for one and preferably more years.

Fertilizers

A 4-8-12 fertilizer derived from sources relatively free of chlorine is commonly used. For best results, it should contain approximately 2 percent magnesia. If more potash is needed, a 4-8-16 mixture may be used. These mixtures are usually broadcast before transplanting at 1,500 pounds per acre. Moderate liming may increase yields and is recommended if soils are below pH 5.6 based on soil tests. If the pH is below 5.6, add enough lime to bring the pH up to this level. Recommendations based on the soil tests should be followed. Soil samples may be sent to the State Agricultural Experiment Station or, in some States, the soil testing laboratory.

Topping and harvesting

After the plant has flowered, Maryland tobacco is usually topped so that 16 to 20 leaves are left on the stalk, depending on soil moisture, nitrogen supply, and variety. The tops should be cut or broken off when the last leaf left on the stalk is a good size to get maximum growth of upper leaves without sacrificing the growth of the lower leaves. Leaves should be harvested when the plants are mature and before there is much deterioration of the lower leaves, usually

about 2 weeks after topping. Suckers should be removed.

Maryland tobacco is harvested much like burley. Growers within both burley and Maryland areas vary in exact harvesting methods with more burley growers spearing immediately after cutting the stalk. After cutting, the plants must be allowed to wilt before field spearing or hauling to the barn for barn spearing. Do not bruise the leaves or allow them to sunburn while wilting. Sticks of tobacco are normally spaced 9 to 14 inches apart on tiers in the curing barn. The exact distance depends primarily on the size of the tobacco and weather conditions at harvest. Large tobacco and humid conditions require wider spacing.

Dark, Air-Cured Tobacco

The types of dark, air-cured tobacco are Green River, One-Sucker, and Virginia Sun-Cured. They are grown in some of the same areas as the fire-cured and burley types in Kentucky, Tennessee, and Virginia. Often, two or more types are grown in different fields of the same farm.

Virginia Sun-Cured Type 37 is grown in a few counties northwest of Richmond. The name comes from the old method of curing on scaffolds in the sun. Now it is air-cured the same as burley, Maryland, and cigar tobacco.

Dark, air-cured tobacco is used for export or in the domestic manufacture of chewing and smoking tobacco.

Types and varieties

Green River Type 36 is grown near Owensboro and Henderson, Kentucky. The same varieties are used to produce this type as are used to produce fire-cured tobacco. In the air-cured area, Ky 151, Little Crittenden, and Greenwood are popular.

One-sucker is grown in and around Logan and Graves counties, Kentucky, and Robertson County, Tennessee (fig. 28). The one-sucker variety most commonly grown is Ky 160. Ky 165, a more recent one-sucker variety, has high resistance to wildfire and tobacco mosaic and medium-high resistance to fusarium wilt and black root rot. Little Sweet Orinoco is common in the sun-cured area.

Soils and fertilizers

Green River and One-Sucker tobaccos are grown on relatively heavy silt loams that contain a high percentage of clay and silt. Virginia sun-cured tobacco is grown on sandy loam with a rather tight clay subsoil.

Fertilizers and rates are much the same as those used for fire-cured tobacco. The soils on which dark, air-cured tobacco is grown are generally low in phosphate. Farm manure is used when available and the crop is generally grown in rotation with other crops, usually after a grass and legume sod mixture.

Topping, harvesting, and curing

Dark, air-cured tobacco is usually topped to leave 15 to 18 leaves per plant. If it is a good growing season and soil fertility appears to justify it, higher topping is followed. Topping stimulates active development of suckers, which must be removed.

Usually 4 to 6 weeks after topping, the leaves will reach their maximum size and will show mottled yellow areas with considerable thickening of the leaf, which becomes brittle when it thickens. Dark, air-cured tobacco is harvested like burley. After the plants are cut, they must be allowed to wilt before they are put in curing barns.

After being placed in the barn, the tobacco is allowed to yellow. During yellowing, the barn should be held at about 80 percent relative humidity, ventilating only enough to prevent houseburn. After the tobacco is yellowed, the ventilator should be opened sufficiently to dry the tobacco.

When curing is completed and the leaf comes into case (pliable but not wet), it is taken down, stripped from the stalk, sorted by class, tied into hands by grade, bulked, and held for market.

Cigar Tobaccos

Cigar tobacco is grown in Massachusetts, Connecticut, Pennsylvania, Puerto Rico, Wisconsin, Ohio, Florida, and Georgia. The finest grades of wrapper leaf are grown in the Connecticut Valley and in a few counties of western Florida and southwestern Georgia.

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FIGURE 28.—Field view of low topping and close suckering of One-Sucker, a dark air-cured type.

Pennsylvania, Ohio, and Puerto Rico produce mainly filler grades. Cigar binder types are grown in Wisconsin, Connecticut, and Massachusetts.

All cigar tobaccos are air-cured. In curing the wrapper types, however, supplemental heat is used as part of the curing procedure.

Leaf from three varietal groups of tobacco is used in the manufacture of cigars. These groups are Broadleaf, or Seedleaf, Havana Seed, and Cuban, each with numerous local strains.

Cigar filler

Cigar filler leaf is produced mainly in the Lancaster, Pennsylvania, and Miami Valley, Ohio, districts in the continental United States. In Puerto Rico, it is grown in the uplands in the vicinity of San Lorenzo, Cayey, Aibonito, Comerio, Caguas, and Utuado, and in the coastal area around Isabela. Puerto Rico upland tobacco is blended with continental filler types in cigar manufacture and most of the Puerto Rico coastal tobacco is prepared as roll chewing tobacco.

Types and Varieties.—Swarr-Hibshman, Swarr, and Greider are Pennsylvania Broadleaf varieties of the older type that are commonly grown in Pennsylvania. Pennleaf 1 is resistant to wildfire and Pennbel 69 is resistant to wildfire and tobacco mosaic; they are grown widely in the Type 41 area, which centers around Lancaster County, Pennsylvania.

Zimmer Spanish and selections from it are the principal varieties grown on upland soils in Ohio. Seedleaf, or Broadleaf, is often called Gebhardt and is grown on the bottom land in the Miami Valley area of Ohio. Little Dutch is grown to a limited extent in Ohio.

Virginia 12, sometimes called V-12, and Olor have been the principal varieties grown in Puerto Rico (fig. 29). Varieties with resistance to tobacco mosaic are being developed, but are not yet available to growers.

Soils and Fertilizers.—Soils used for filler leaf are heavier textured and have higher water retention capacity than soils used for binder.

These soils are well adapted to general farming and tobacco is usually grown on them in rotation with other regular farm crops in a 2- to 6-year rotation.

Silt loams derived from limestone are used for growing tobacco in Pennsylvania. Silt loams and silty clay loam are the principal soil types used in Ohio. Underdrainage of these soils is sometimes poor and often requires the use of tile. The tile is placed a few feet below the soil surface where it will not interfere with cultivation and is installed so it will drain to a lower outlet.

In Puerto Rico, upland cigar-filler tobacco is grown on brown soils and on soils derived from granite. The coastal tobacco is grown on soils derived from limestone.

In Pennsylvania and Ohio, animal manure is broadcast before transplanting at rates of 10 tons or more per acre. As a supplement, 4-8-12 fertilizer is applied at a rate of 1,000 to 1,500 pounds per acre. Where soil tests by the county agent show high available potash, fertilizers supplying 50 to 100 pounds each of nitrogen, phosphorus, and potash per acre are used. The chlorine in these plant nutrients should be kept as low as possible.

In Puerto Rico, the crop is fertilized with 500 pounds per acre of 6-8-10 fertilizer at transplanting and a similar amount 30 days after transplanting. The fertilizer is applied by machine in bands on each side of the row.

Topping and Harvesting.—In Ohio and Pennsylvania, the plants are topped 2 to 3 weeks before harvest and before any blossoms are evident. From 12 to 16 leaves should be left, depending on variety and growing season. Suckers should be cut or broken out when necessary.

In Ohio and Pennsylvania, plants are harvested when fully ripe, as indicated by a pale green color, mottled appearance, and increased thickness and brittleness of the leaves. The plants are cut off near the ground to wilt when the weather is clear and the plants are free from dew. Wagons fitted with racks are used to haul the tobacco to the curing barn or the area where it is speared on sticks and allowed to wilt on racks. A horizontal pole may be constructed in the field and the tobacco hung by hand for wilting (fig. 30).

In Puerto Rico, harvest in the uplands begins about 35 days after transplanting. Topping may begin before the first priming and continue during the priming of the lower leaves. Because of variation in growth, all plants within a field are not topped at the same time. The lower three or four leaves are primed first. Later pickings consist of three or four leaves or more and continue until all the leaves are removed from the stalks.

The leaves are either wrapped in burlap sheets or placed in wooden trays covered with burlap and carried to the curing barn. There they are strung with a needle and string and the strings are then tied to a stick or to the tier poles of the barn.

Coastal tobacco is topped at 12 to 14 leaves at flowering time. It is harvested when the leaves are a light green color. The entire plant is cut, and after wilting, two plants are tied together by fiber from Sanseveria leaves and hung over a stick for curing.

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FIGURE 29.—Puerto Rico cigar-filler tobacco: A, Virginia 12 variety grown principally in the uplands; B, variety similar to Cuban tobaccos grown in the coastal areas.

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FIGURE 30.—Tobacco in Pennsylvania is allowed to wilt on racks before hanging in the curing barns.

Cigar binder

Cigar binder tobacco is grown in Connecticut, Massachusetts, and Wisconsin. Some of it is used in the manufacture of reconstituted cigar binder with the greater portion of it in the manufacturing of scrap chewing. Limited quantities of tobacco grown in Pennsylvania, Minnesota, and New York are also used for these purposes. The use of scrap chewing has increased in recent years.

Types and Varieties.—Connecticut Broadleaf, also called seedleaf, is grown in Connecticut for binder. Broadleaf strains are also grown in Pennsylvania and Ohio where they are given the name of the State where grown. The Havana seed group is grown in the northern cigar binder tobacco producing districts, mainly in Wisconsin with very small acreages in Pennsylvania, New York, and Connecticut. In Wisconsin, Havana 142, Havana 307, Havana 501, and Havana 503 are grown. All are resistant to black root rot but Havana 501 and 503 are also resistant to wildfire and tobacco mosaic.

Soils and Fertilizers.—In the Connecticut-Massachusetts area, binder leaf is produced on very sandy loams. The subsoil is well drained sandy loam or very fine sandy loam. In southern Wisconsin, tobacco is grown on both light and dark-colored silt loams. In the Vernon County area of northern Wisconcin, cigar binder leaf is grown on light-colored silt and clay loams located on the ridges and on extensive, dark, prairie silt loams. In the valley, both light and dark fine, sandy and silt loams produce Wisconsin's finest-quality cigar binder-type tobacco.

When animal manure is available, it is plowed under, preferably in the fall. Manure is not used extensively in the Connecticut-Massachusetts area because it is not available. In Wisconsin, 15 ot 20 tons of animal manure per acre are supplemented with 500 to 1,200 pounds of 5-5-30S, depending on soil tests, and plowed under with the manure. Winter rye cover crops are used in Wisconsin to prevent erosion and maintain organic matter where less manure is used.

In the Connecticut valley, the actual quantity of mixed fertilizers to be applied varies with the character of the soil. Less is applied on heavy soils and more on lighter soils. Usually an application of 2,500 pounds per acre of 8-4-8 that also contains 2 to 4 percent magnesia will supply the necessary nutrients. The fertilizer is usually broadcast before transplanting. If rainfall becomes excessive during the growing season, 200 pounds of nitrate of soda or 100 pounds of ammonium nitrate per acre are applied immediately after a heavy rain. The fertilizer is drilled in alongside the plants with a

cultivator attachment at a depth of 3 or 4 inches on one or both sides of the row.

A moderately acid soil aids in the control of the black root rot disease. If, however, the soil pH is 5.0 or lower, the nutrition of the plant may be upset and deficiency of such elements as maganese, calcium, and potassium may develop. A heavy application of limestone to the soil can affect the burning qualities of the tobacco in the cigar with an undesirable flakiness of the cigar ash. It may also interfere with the availability of the potash to the growing crop and produce deficiency disease complication if the soil becomes too alkaline. Soil tests by the State soils laboratory or a fertilizer company will show what the fertilizer needs are.

Topping and Harvesting.—Cigar binder tobaccos usually are topped about 2 to 3 weeks before harvest. When the plants begin to flower, the tops are broken off, leaving from 15 to 18 leaves on the plant. The number of leaves left is based on fertility of the soil, variety grown, and vigor of the individual plant. If the tobacco is over fertilized and the plant grows vigorously, then more leaves should be left on the stalk. Suckers should be removed at least once before harvest.

Plants of cigar binder tobacco are harvested when the middle leaves are ripe, as indicated by a lighter shade of green. At this stage, the lower leaves of the plant will tend to be more or less overripe and the top leaves will show varying stages of maturity.

The stalks of the plants are cut near the ground with a special hatchet and the plants are laid on the ground to wilt before they are handled so the leaves are not broken off the plants and lost. On a hot clear day when there is little air movement, the plants must be speared on the lath and taken to the curing barn as soon as possible to avoid sunburn spots on the leaves, which remain green even after curing.

Five or six plants are speared on a 4-foot lath by means of a removable metal spear which is placed on one end of the lath. Some growers place one end of the lath on the ground and then force the spear through the lower end of the stalk. The stalks are speared about 6 to 8 inches from the base of the plant in such a manner that the stalks do not break open and allow the plants to fall off the lath. The plants are then placed on a specially built rack for hauling the tobacco to the curing barn. Other growers use a spearing horse or jack which holds a lath in a horizontal position about 4 feet off the ground in such a manner that the plant can be speared on the lath.

The rack for hauling the tobacco to the curing barn may be mounted on a trailer that is drawn by a tractor, or on a pickup truck. Two racks may also be mounted side by side on a flatbed truck for hauling tobacco to the barn. The racks are constructed of 4-inch by 4-inch lumber, 5 feet high, with 3 feet 4 inches between the sides so that the laths will stay in place on the rack. Sixteen to 18 foot racks are common with smaller racks for smaller vehicles.

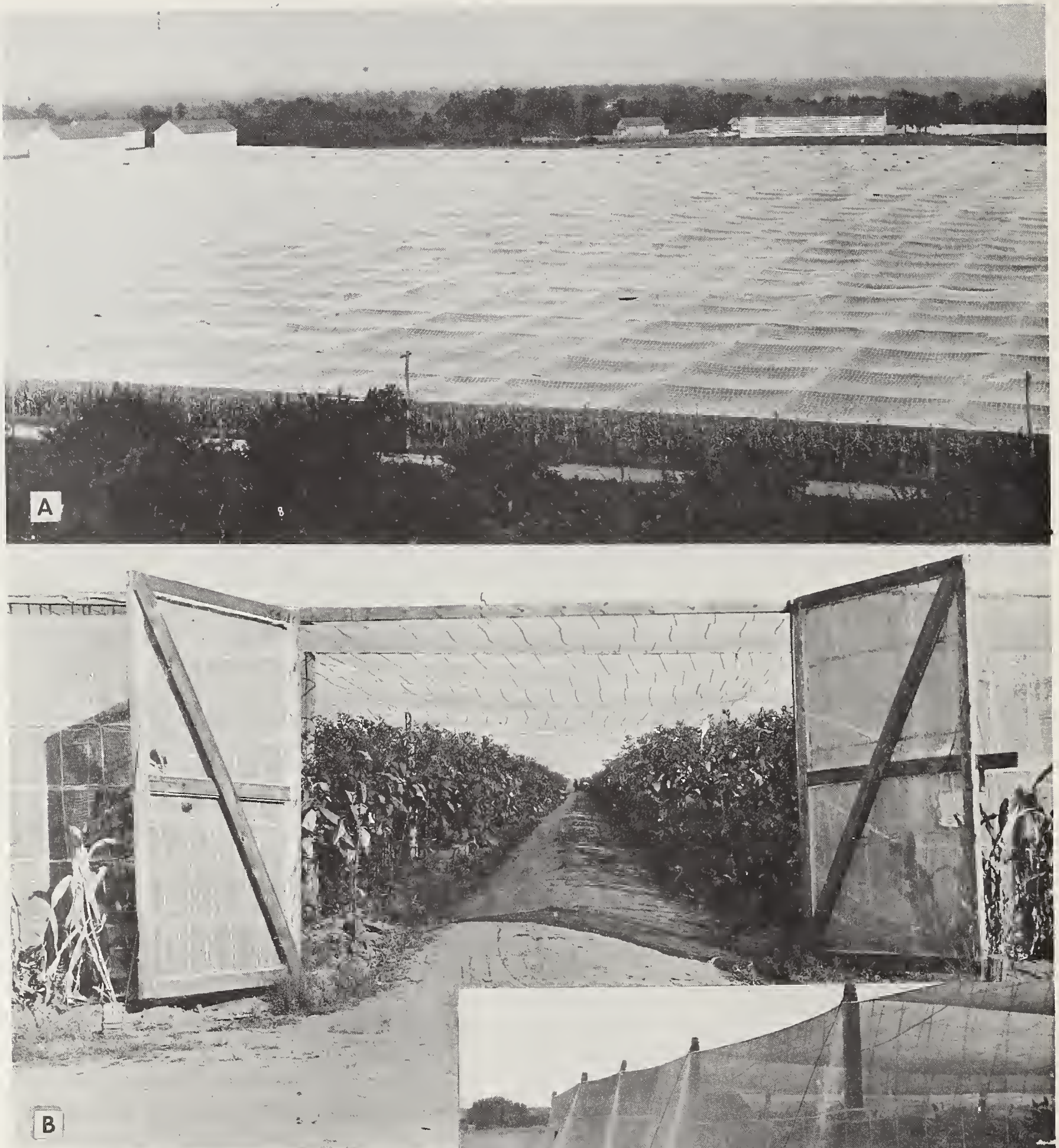
Shade-grown cigar wrapper

Cigar wrapper of the best quality is grown under cloth shade in parts of Connecticut and Massachusetts; Gadsden County, Florida; and Decatur County, Georgia. The artificial shade results in a thinner, smoother leaf with small veins suitable for fine cigar wrapper. Plant covers reduce light intensity and wind movement, which results in reduced evaporation and increased humidity (fig. 31). This produces thinner and longer leaves more adequate for use as cigar wrappers.

Types and Varieties.—Orginally, tobacco of Cuban origin was used in cigar-wrapper production. An increasing disease problem and the need for higher yielding varieties caused a need for improved varieties. As a result, plant breeders for the tobacco companies have developed and released their own varieties which are vastly improved in yield, quality, and disease resistance over the original types, For this reason, the different varieties of cigar-wrapper tobacco are not named.

In Connecticut and Massachusetts, tobacco company breeders produce varieties specifically suited to the conditions and problems of that area. Also, breeders are developing varieties for the Florida-Georgia area. A new variety, Florida 17, is being planted in that area; it has resistance to black shank and weather fleck.

Tobacco mosaic, black root rot, wildfire, and fleck are serious diseases in Connecticut but are controlled by resistant varieties. The ozone-induced leaf condition, commonly known as



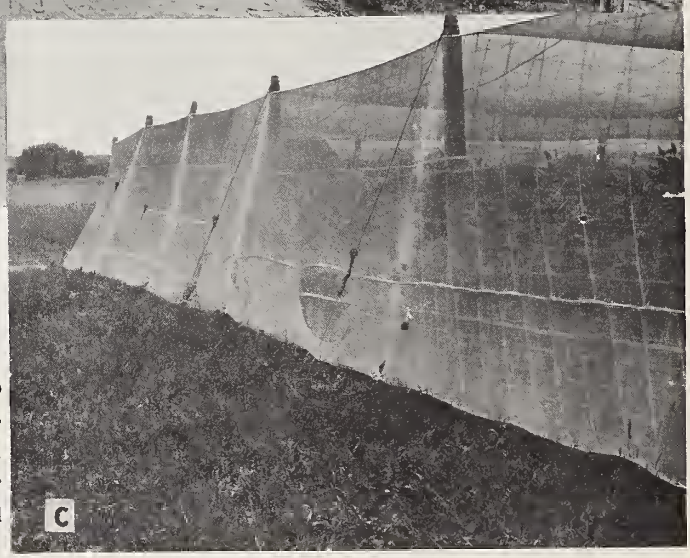


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FIGURE 31.—Shade for Connecticut cigar-wrapper tobacco: A, large field covered with cloth; B, interior view showing mature crop with lower leaves harvested; C, exterior view of sidewalls and method of anchoring side posts.

weather fleck, is also partially controlled by tolerant varieties. In Florida, varieties should be resistant to weather fleck, blue mold, root knot, and black shank.

Soils and Fertilizers.—In Florida and Georgia, shade wrapper is grown on fine sandy loams to sandy loams, with well-drained subsoils. In the Connecticut valley area, shade tobacco is produced chiefly on coarse sandy loam.

Fertilizer is usually custom blended to fit the growers' needs in the Connecticut valley. About 3,000 to 3,500 pounds per acre of 6-4-7, with most of the nitrogen from organic vegetable meals, is common. In the Florida-Georgia area, generally 3,000 to 3,500 pounds of 5-4-6 is common. Twelve to 15 tons of manure is used if available, and adjustments are made in the amount and kind of mixed fertilizers applied.

Artificial Shade.—Shade tents consist of a wire frame about 33 feet wide and supported by stout posts around all sides of the field. The posts must be substantially anchored by suitable bracing. Cloth shading is attached over the top and sides (fig. 32). It is called shade cloth and is manufactured especially for shade grown tobacco. The cloth is a course, loosely-woven material containing 8 threads to the inch one way and 10 the other. It is reinforced with closely woven strands spaced at regular intervals. In the Florida-Georgia area, usually heavier cloth of 12 X 12 or 10 X 12 threads per inch is used.

Tobacco cloth is in strips 33-1/3 feet wide and 125 feet long. It is stretched and securely fastened by sewing it to the supporting wires. The cloth is placed on the frame in the spring before transplanting and is removed after the crop is harvested. The cloth that was used on top of the frame the previous season is doubled and used on the sides of the frame the next season.

If yellow, lead-chromate-treated cloth is used, it may last on top for two seasons.

Harvesting.—The tobacco leaves are picked, or primed, as they ripen in harvesting all shade-grown tobacco (fig. 33). The leaves are not as ripe at harvest as stalk-cut tobacco. However,

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FIGURE 32.—Preparing shade for cigar wrapper tobacco in Connecticut.

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FIGURE 33.—Harvesting cigar wrapper tobacco by priming or picking the ripe leaves.

proper ripeness is very important because texture, body, color, and elastic qualities of the cured leaf depend on proper development. Usually, the first picking of three or four lowermost leaves is made at the time the flower head forms. Subsequent pickings of three or four leaves are usually made at weekly intervals, progressing up the plant until all usable leaves are picked. The plants are not topped.

As the leaves are taken from the plant, they are stacked in piles in the row with the top side up. Piles are then placed in canvas-lined baskets to avoid bruising and hauled to the curing barn. Here a stringing machine is used to pass twine through the stem about 1 inch from the base of the leaves.

The lath to which the string is attached has a saw notch at each end into which the string is drawn (fig. 34). Each lath holds 18 to 20 pairs of leaves.

Curing Barns

The air-curing barn should be located in an open well-drained area and, where possible, on a rise of ground. For best ventilation, a side should face the prevailing winds. Width is the most important dimension because it determines the distance through which ventilating air moves in the barn and the quantity of tobacco in the path of the air. If the sides of the barn have the proper number of ventilator doors and one side faces the prevailing winds, the height and length of the barn will not appreciably affect the removal of moisture from the tobacco. Any changes in the barn that increase ventilation will increase barn capacity and reduce the cost of housing space.

Barns must conform to sound construction practices. The traditional barn is 40 feet wide and 60 feet or more long with sidewalls 20 feet

high and a gable roof of one-third pitch. Ventilation should be provided by full length, sidewall, hinged, vertical doors that should be equivalent in area to not less than one-third and preferably one-half of the side. Figure 35 shows a barn for curing cigar tobacco and figure 36 shows a burley curing barn.

Air curing gives satisfactory results in dry, warm weather. When tobacco is hung in the barn, water evaporates from the leaves and the barn becomes saturated with moisture. Evaporation will soon stop unless the moisture is removed from the barn by circulating the air.

In moderately dry weather, ventilation is all that is needed for proper curing provided the temperature is not below 50° F. In very dry weather, evaporation from the leaves can be kept in check by having a tightly built barn and by keeping the ventilators closed during the day and about half open at night. If the temperature is below 50° F., curing stops and the tobacco may continue to dry out; the leaf is simply dried and not cured.

Under favorable conditions, curing periods for various air-cured tobaccos range from 4 to 8 weeks. The temperature should be kept up, and adequate moisture provided, but not too much to cause mold. The tobacco is cured if the midrib of the leaf is dry enough to snap when bent between the fingers. The stalks may still be green at this stage.

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FIGURE 34.—Preparation of leaves of Connecticut shade wrapper for curing: A, lath showing method of attaching string; B, arrangement of leaves on string with pairs face to face and back to back.

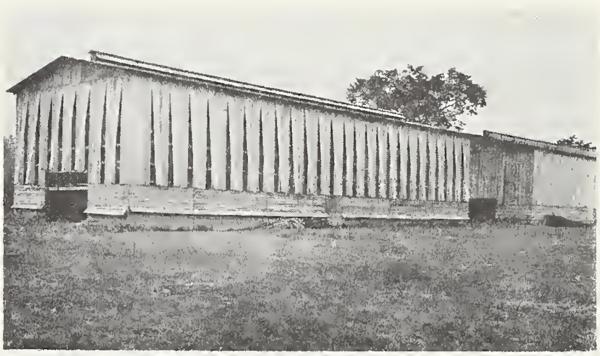

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FIGURE 35.—This barn for curing cigar tobacco has vertical ventilators on sides and horizontal ventilators on peak of the roof and near the foundation.

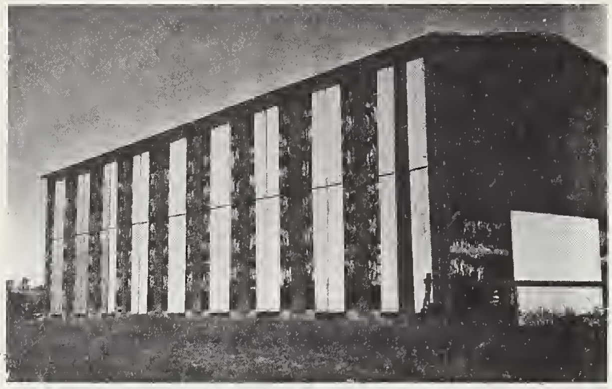
If the dried leaf has a mottled color, usually of yellow and dark brown, the color can be evened by alternately casing (allowing the leaves to absorb moisture) and drying the leaves. If dry weather prevents doing this before the midrib dries, it can be done later.

Tobacco should be dried as quickly as possible after each casing. Stalk-cut tobacco should be stripped and the leaves sorted as soon as possible after curing is completed.

Sunlight damages tobacco color after curing so it should not be exposed to sunlight in the barn or later. Wind may bruise the leaves near doors and ventilators unless these openings are closed during high winds.

Leaf changes in curing

When curing is first started, while the leaf is undergoing starvation, it is also gradually losing water. During curing it is important to regulate the rate of drying. If drying is too rapid, the leaf is killed prematurely and if too slow, the curing goes too far. The rate of drying depends principally on the humidity in the barn. Fully ripe leaf is high in starch and an important part of curing is to remove this starch, which is consumed largely by the living part of the leaf.



PN-4274

FIGURE 36.—Burley tobacco curing barn.

If the leaf is killed by bruising, rapid drying, or too much heat, there is no way to remove the starch. This leaves the tobacco lifeless, green, strawy, and with a bad taste when smoked. During the starvation period, there are also color changes.

The full development of the yellow color marks the end of the first period of curing. During the second stage, the color may become yellow to brown or red, depending on tobacco type.

These color changes are caused by oxidation that does not take place until the cells of the leaf are dead. Air and moisture are necessary to develop a brown or red color. In air curing, the principal danger is that excess moisture may cause the tobacco to become too dark.

Tobacco leaf ordinarily loses about 75 percent of its green weight in curing, most of which is water. Thus, tobacco yielding 1,800 pounds of cured leaf per acre weighs about 8 tons when harvested, including stalks. Of the 8 tons, fully 6 tons is water. To cure tobacco successfully, most of the water must be removed at such a rate that the important chemical and color changes will take place. No cure should be too slow but care should be taken not to have too much moisture in the barn. This generally takes care of itself because the cool weather in the later part of the cure tends to produce less moisture.

Temperature and ventilation

The living cells of the leaf are killed by excessively low or excessively high temperatures and by loss of water. In practice, the best temperatures for the first stage of most air curing are 60° to 90° F., provided relative humidity is maintained at 65 to 70 percent. After the first stage, temperature and humidity are not as important except to prevent rotting or molding. Fire can be used, but the temperature in the barns should never be above 90° F. For Maryland tobacco, the best temperatures are from 80° to 90° F., with a relative humidity of 75 to 80 percent. Under these conditions, the leaf gradually loses its water and does not become brittle. If the humidity becomes higher, pole-sweat develops on the leaves most advanced in curing; if the humidity becomes much lower, the leaf dries out too rapidly.

Unfortunately, most growers are unable to control temperature and humidity in the barn. If the weather is too dry, the tobacco hays down, that is, dries out like hay. During very wet weather, serious damage is caused by pole-sweat, or house-burn.

After curing, do not allow the tobacco to absorb too much moisture. If it does it will decay.

Supplementary heat

During rainy or foggy weather, evaporation of water from tobacco is severly retarded or it stops; sometimes, the moisture in the tobacco may increase. Under these conditions, extra heat is required to reduce the humidity in the barn. If barn temperatures can be maintained 10° to 15° F. higher than the outside air, and the barn is properly ventilated, the grower can control curing conditions. There must be enough ventilators in the barn to control moisture. The grower should check his barn constantly and decide how much the ventilators should be open.

To drive out the moisture, enough heat must be supplied to warm the barn to the top. When the temperature is below 50°F., heat is needed for good curing, regardless of the humidity, because tobacco cannot cure properly at low temperatures. Shade-grown tobacco is partially cured with artificial heat at all times. For other types, very little superficial heat is used.

Small charcoal fires on the barn floor, if the floor is dirt, or coke in stoves usually provides extra heat for air curing. Moderate heat is maintained for 2 to 3 days, depending on weather conditions.

Liquid petroleum (LP) gas is the common fuel used for curing shade-grown wrapper tobacco and is increasing in use for other tobacco types.

House-burn or pole-sweat

During prolonged wet weather and high temperatures, house-burn, or pole-sweat (pole-rot) may occur on the curing leaf. In most localities, burn means discoloration, usually black, and brittleness without decay; sweat, or rot, means a breakdown and decay of the leaf web, or midrib, and larger veins. These burns and sweats, or rots, do not often appear in cold weather.

All three of the following conditions are necessary for the rapid spread of the decay. They are (1) tobacco that has passed through the first stage of curing or has been killed by bruising or other injury; (2) a temperature ranging from 60° to 100°F; and (3) a relative humidity of 90 percent or more, which checks the evaporation from the leaves. Conditions favorable to pole-sweat may exist for short periods without decay developing but it is likely to occur if these conditions continue for 24 to 48 hours.

The only practical way to control the humidity in the curing barn during excessively damp weather is to use supplemental heat; increase the barn temperature 5° to 15° F. above the outside air and carefully ventilate for 3 to 4 days.

Sun curing

Sun-cured tobacco is often exposed to the sun or open air for 4 to 6 days immediately after harvesting in Caroline, Louisa, Hanover, and adjoining counties in Virginia; and in Pennsylvania. The curing then is completed in the barn without artificial heat, the same as for other air-cured tobacco.

Virginia sun-cured is used mainly for chewing, and exposure to the sun is thought to improve the flavor.

In sun-curing, the sticks filled with plants are crowded close enough together for the leaves to touch on scaffolds erected near the barn. After the leaves have yellowed, the sticks are spread far enough apart for good air circulation and left on the scaffold a few days longer. If there is rain during this period, the tobacco should be placed under a shed or plastic cover. Because of the increased cost of handling, very little tobacco is now sun-cured.

Stripping and Sorting

After air-curing, stalks should be taken from the sticks as soon as possible and piled in heaps or bulks. The leaves are then stripped off as soon as possible. This cannot be done until damp weather has made the leaf pliable enough to be handled without breaking. When tobacco becomes pliable, it is in a condition called in case or in order. Tobacco will not come into order in low temperatures below 50° F. Even during wet weather.

If the stalks have been frozen, the plants should hang while thawing until dripping stops to avoid staining. Where case weather is infrequent, most of the crop is taken down at one time. To do this, the stalks should be dry and the temperature below 50° F. so the bulks of tobacco in the barn will not heat. By December, these conditions usually have been reached in most areas that stalk cut tobacco is grown.

In some filler districts of Pennsylvania, sticks are hung in dampening cellars, usually under the grading room or sorting room, to bring the tobacco in case. From the cellar, the stalks are taken to a sorting room and stripped (fig. 37).

As the stalks with the cured leaf are taken from the sticks, they usually are piled in heaps on poles or boards on the floor. This is done to let air circulate under the pile to prevent rotting of the bottom stalks. The tips are all turned inward and overlapped to prevent the leaves from drying out. The heaps or bulks may be covered with tarpaulin, mats, stalks, or other materials to prevent drying. The bulks may become heated unless they are stripped as soon as possible.

As the leaves are stripped from the stalk, they are placed in grades according to length, soundness, and type of tobacco.

Pennsylvania filler tobacco is generally packed by the grower in two farm grades, frequently without being tied into hands and without being sized into lengths. The lower leaves and any damaged leaves higher on the stalk make up one grade and the remaining leaves usually make up the other grade.

Grading on the farm in Wisconsin is limited to a farm filler grade consisting of bottom, or sand, leaves; a stemming grade of short, damaged, and heavy top leaves; and a binder grade of good quality, ripe, well-cured leaves.

Some growers place all the leaves into one lot,

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FIGURE 37.—Stripping leaves of cigar tobacco from a lath of cured plants.

which is called straight stripped, or crop, lot; however, it is not a common practice.

The various air-cured types of tobacco are usually sorted in the following grades, with further breakdowns according to quality or color.

1. **Burley tobacco** is tied into hands of 35 to 40 leaves after stripping and bulked down. The common farm grades from bottom to top on the plant are flyings, trash, lugs, bright leaf, red leaf, and tips.

2. **Maryland tobacco** is usually tied in hands with the seconds, bright leaf, and dull leaf separated.

3. **Dark air-cured tobacco** is separated trash, lugs, and leaf, and it is tied in hands.

4. **Sun-cured tobacco** is separated into lugs and leaf and is tied in hands. Lugs are at the bottom and leaf is the rest of the plant.

5. **Cigar tobacco** is separated into binders, fillers, stemming, and wrappers.

In cigar filler and binder districts, the leaves are usually made into neat bundles, or bales, by means of a form and pressure jack; then the bundles are wrapped with heavy paper and tied with twine. These bundles usually weigh 30 to 60 pounds (fig. 38). Burley and Maryland tobaccos are usually tied in hands of 35 to 40 leaves and sold with the tied hands on baskets containing 100 or more pounds of leaf (fig. 39). Some Maryland tobacco is sold in hogsheads containing 700 to 800 pounds of leaf.

Before cigar tobacco leaf is ready for the manufacturer, it must undergo a process of fermentation, commonly called sweating. Therefore, growers sell their leaf in bundles, or in cases, to packers who carry out the grading and fermentation.

PERIQUE TOBACCO[1]

Perique tobacco is grown to a limited extent in Louisiana on the better drained soils of St. James Parish. It is a distinct type of tobacco; the plants resemble those grown in the coastal region of Puerto Rico (fig. 40).

Power machinery is used to cultivate the crop, if possible, but much hand hoeing is often necessary.

The varieties and methods of culture resemble those in the fire-cured type. No one knows the names of the varieties. They have been grown by farmers for many years. When about 2 feet high, the plants are topped at 12 to 14 leaves and the suckers are removed by hand, usually about three times.

Perique tobacco is harvested in June or July before the bottom leaves begin to deteriorate by cutting the stalk near the ground level. The work takes place in the heat of the day so that the sun will wilt the leaves before they are taken to the drying sheds or barns. After the stalks are taken to the barns, a nail is driven at an angle in the butt of the stalk so the plants can be hung on wire stretched across the barn. The barns are well ventilated at the bottom, but closed at the

[1]Information on perique tobacco was taken from "St. James Parish" History and Resources, Louisiana Cooperative Extension Service, Kermit Coulon, County Agent.

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FIGURE 38.—Bale of cigar tobacco ready for market sitting on top of a baling box with press to the left.

top. The tobacco is air-cured in this manner for 8 to 14 days.

After curing, the leaves are removed from the stalks and whipped over a barrel to get the dust and foreign matter off. The tobacco has to have sufficient moisture for the leaves not to break or crumble. The moisture is added by sprinkling. As the leaves are removed from the stalks, they are placed in tubs or boxes, covered with damp burlap sacks to keep them in condition for the grading and stemming (removing the midrib) which follows immediately.

As the leaves are graded and stemmed, they are made into twists or "torquettes" which weigh about 1 pound each. The better leaves are used to cover the twists and tie them. The twists are placed tightly in heavy wooden barrels strengthened by 8 or 10 iron bands. It is in these barrels that the tobacco is subjected to great pressure by means of a screw jack, of the type used to raise houses (fig. 41). This pressure

PN-4277

FIGURE 39.—Burley tobacco ready for sale.

PN-4278

FIGURE 40.—Field of perique tobacco in Louisiana. (Courtesy The Tobacco Institute)

PN-4279

FIGURE 41.—Barrels of perique fermenting under pressure in the curing barn. (Courtesy The Tobacco Institute)

causes the juice to come out of the leaves and the tobacco soaks in its own juice.

When the leaves have soaked in their own juice for about 2 weeks, the pressure is released and the twists are taken out, opened up and aired, and, if necessary, dampened with water before being put under pressure again. The number of times the twists are turned vary but usually it is about four times. This process is continued until the tobacco is marketed, usually in late December.

CONTROL

The pesticides mentioned in this publication are available in several different formulations that contain varying amounts of the active ingredient. Because of differences in active ingredient, dosage rates are not indicated in this publication.

The user is cautioned to read and follow all directions and precautions given on the label of the pesticide formulation that will be used.

HERBICIDES FOR WEED CONTROL

Among the most important weeds found in tobacco are: crabgrass, lambsquarter, smartweed, morning glory, nutsedge, and cocklebur. Herbicides can be used to control these and many other weeds. The herbicides registered for use on tobacco are benefin (N-butyl-N-ethyl-a,a,a-trifluoro-2, 6-dinitro-p-toluidine); isopropalin (2, 6-dinitro-N, N-dipropylcumidine); diphenamid (N,N-dimethyl-2,2-diphenylacetamid); pebulate (S-propyl butylethylthio-carbamate); and vermolate (S-propyl dipropylthiocarbamate). Uses of pesticides are subject to change in registration.

Local, State, or Federal authorities should be consulted before applying herbicides on tobacco because most registered uses of herbicides are confined to certain geographical areas or certain tobacco types and because environmental factors may drastically influence the reaction of both tobacco and weeds to herbicides.

Herbicides discussed here fall into two general categories: (1) those that are incorporated into the soil before transplanting and (2) those that are applied after transplanting. Herbicides that are incorporated into the soil before transplanting are benefin, isopropalin, and pebulate. Post transplanting herbicides are diphenamid and vernolate.

Isopropalin is registered for use in burley and flue-cured tobacco fields. It must be applied and incorporated into the soil in the field any time from 5 weeks before transplanting up to the day of transplanting. Incorporate isopropalin into the soil with power-driven equipment set to cut 3 to 4 inches deep. If a double disk is used to incorporate isopropalin, cross-disk and cut the soil 4

to 6 inches deep.

Benefin is registered for use only on burley and dark tobaccos. Benefin should be broadcast. Tobacco should be transplanted so that all roots extend below the benefin treated zone, otherwise the plants may be damaged and the growth stunted. The incorporation procedures for benefin are similar to those used for isopropalin. Consult the manufacturer's label for specifics.

Isopropalin and benefin satisfactorily control many annual weeds, especially grass, but they will not control such large-seeded, broadleaf weeds as cocklebur, jimson weed, and sicklepod.

Pebulate is registered for use only on flue-cured tobacco. It may be applied either before or after bedding. If pebulate is applied before bedding, broadcast and incorporate with a tandem disk harrow set to cut 6 inches deep.

After beds are formed, pebulate can be incorporated with a power-driven rotary hoe set to cut 3 inches deep. Depth of incorporation can be precisely controlled if the bed is leveled prior to herbicide application or if a rotary hoe with variable length tines is used to maintain the shape of the bed. Power-driven rotary hoes incorporate herbicides with more precision than do disk harrows.

With either method of incorporation, best results are obtained when the soil is neither too dry nor too wet but contains the right amount of moisture for planting. Because pebulate is very volatile, it must be incorporated immediately after application. Mounting the sprayer in front of the incorporating device will minimize losses from evaporation.

Pebulate may also be broadcast as a subsurface spray through covered sweeps running 3.5 to 4 inches below the surface of the leveled bed. In the finished bed, at least 3 inches of soil must cover the subsurface layer of pebulate. Subsurface-applied pebulate, compared to the same rate incorporated, may increase the degree of weed control, espenially of nutsedge, because pebulate is lost from the soil by vapor action.

Tolerance of tobacco is lower if pebulate is subsurface applied. The flat-running, subsurface sweeps, operated properly, leave the surface of the bed flat and in excellent condition for receiving transplants. Compared to post-bedding incorporation, subsurface placement conserves moisture because the bed remains relatively undisturbed.

Pebulate is effective in the control of nutsedge and many annual weeds in tobacco fields. It does not control cocklebur or Florida beggarweed.

Vernolate is registered for tobacco in Kentucky, Maryland, and Virginia. Vernolate is incorporated 7 days after transplanting tobacco. The rotary hoe incorporator should be adjusted to (1) cut 1-1/2 to 3 inches deep, depending on the type of hoe used, and (2) throw vernolate treated soil toward the tobacco transplants. The kind of weeds controlled by vernolate are about the same as for pebulate.

Where a herbicide is incorporated after bedding, the incorporation should be done in a manner not to disburb the fertilizer at the bottom of the bed. Also, for weed control over a maximum period of time, the application of disk-incorporated herbicides must be coordinated with fumigant-type nematicide treatments because certain fumigants require a 2- to 3-week waiting period. For example, if both the fumigant nematicide and herbicide are applied broadcast prior to bedding, apply the nematicide first and then at the end of the waiting period, incorporate the herbicide.

Diphenamid can be used on all tobacco types. Apply diphenamid over the top of the transplants or direct the herbicide to the base of the tobacco either after transplanting or at layby (last cultivation). Because diphenamid will not control emerged weeds, it must be applied to bare soil. Grass often becomes a problem during harvesting. This is especially important in machine harvesting, since the grass will be harvested along with the tobacco. Even when a herbicide is used at transplanting, untreated soil is exposed during the last deep cultivation, resulting in a growth of grass in the middle of the rows. Therefore, a herbicide treatment at layby increases the degree of weed control.

Although used normally as a surface spray, diphenamid may be incorporated one-half to 2 inches deep within 24 hours after application if the soil remains dry. In lieu of incorporation, a preferable procedure is to surface-apply the herbicide and then irrigate with about one-half inch of water because adequate moisture is essential for good results. If no rain occurs, repeat the irrigation in 7 to 10 days.

Diphenamid controls many annual weeds. However, the effectiveness of diphenamid is reduced, especially on certain broadleaf weeds, unless adequate moisture is provided. It will not control ragweed and galinsoga or such large-

seeded weeds as black nightshade, cocklebur, morning glory, sicklepod, and velvet leaf.

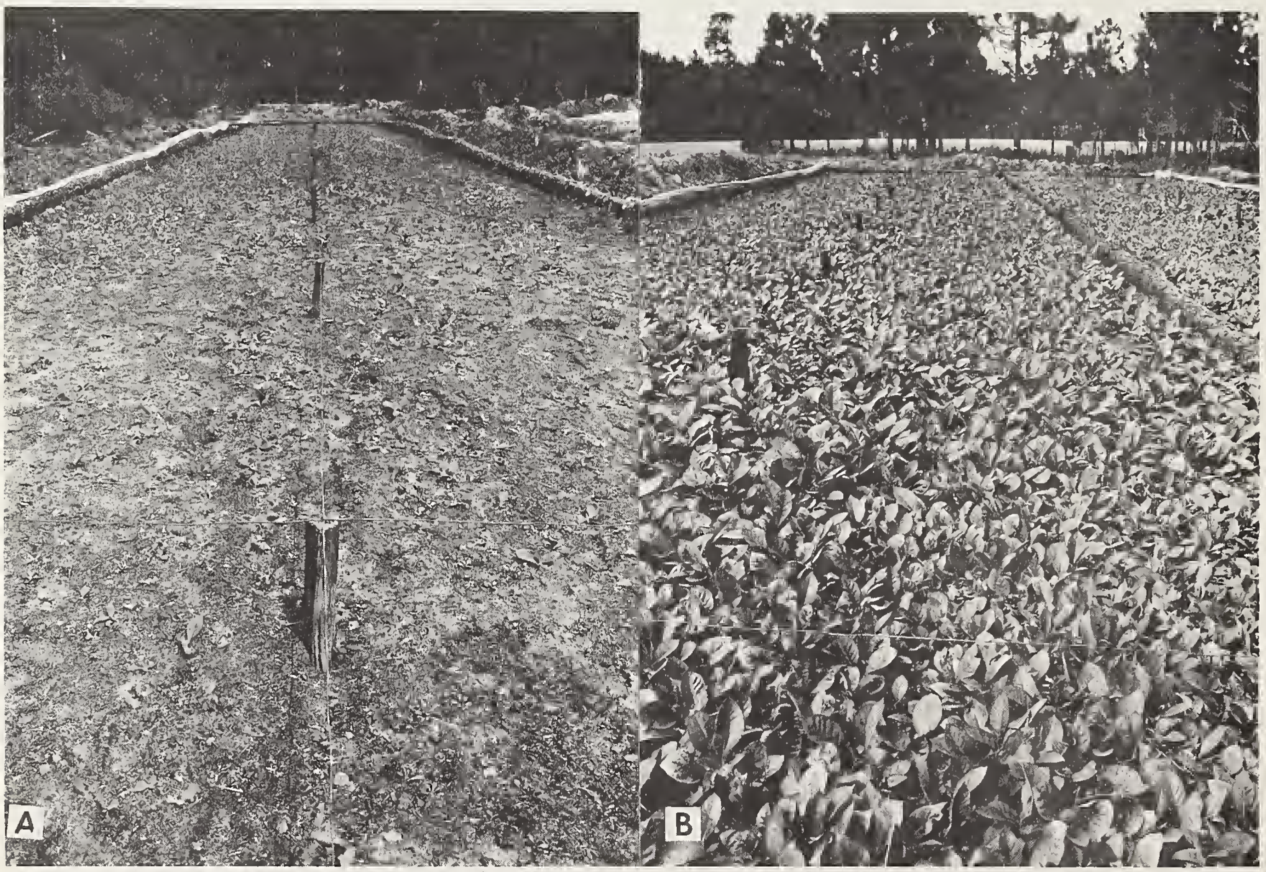
Residues from diphenamid may persist after crop harvest, especially on heavier tobacco soils. Edible crops, except those for which it is registered, or small grain should not be planted in diphenamid treated soil within 6 months after application. Band application over the tobacco row will reduce the amount of residue left in the soil. Before planting subsequent crops, the soil should be thoroughly plowed and disked. To use herbicides effectively on tobacco, they must be applied properly and with precision. The county extension service and manufacturer's label should be consulted for rates. The rates of application are *very important*, as too little may not control the weeds and excess may damage the crop. Also, weeds must be identified because none of the herbicides control all weeds.

DISEASES

The tobacco plant is attacked by a number of diseases in both the seedbed and field (figs. 42 and 43).

The use of healthy plants is the first step in controlling diseases and producing a good crop. Tobacco trash can be used as a fertilizer for many crops but it should not be used on tobacco, either in the seedbed or field.

Weeding or pulling plants from the bed should not be done immediately after handling tobacco



PN-4280

FIGURE 42.—A, blue mold destroyed all but about 1,000 plants per 100 square yards in this unsprayed seedbed; B, sprayed seedbed produced 40,000 tobacco plants per 100 square yards.

or tobacco products unless the hands have been washed with soap and water or with milk if it is available. Milk appears to deactivate the mosaic virus.

Location of the seedbed and soil sterilization are important aids in disease control. Tables 7 and 8 identify the major tobacco diseases and table 9 identifies the major malnutritional disorders (fig. 44). The tables also give the most effective control measures. Growers should see their county agent for detailed instructions on the use of chemical controls.

The causal organisms of the most common tobacco diseases are as follows:

Disease	*Causal Organism*
Angular leaf spot and Blackfire	*Pseudomonas angulata* (Fromme & Murray) Holland (A non-toxin producing form of *Pseudomonas tabaci)*
Anthracnose	*Colletotrichum destructivum O'Gara*
Bacterial wilt	*Pseudomonas solanacearum* E. F. Sm.
Black root rot	*Thielaviopsis basicola* (Berk. & Br.) Ferr.
Black shank	*Phytophthora parasitica* Dast var. *nicotianae* (Breda de Haan) Tucker
Blue mold	*Peronospora tabacina* Adam.
Brown spot	*Alternaria alternata* (Fries) Keissler (Previously called *alternaria tenuis* Vees)
Cucumber mosaic	Cucumber mosaic virus (CMV)
Cyst nematode	*Heterodera tabacum* Lownsbery and Lownsbery (only in Conn. and Mass., and a closely related species in Virginia).
Damping off	*Pythium debaryanum* Hesse in spring; *Rhizoctonia solani* Kuhn in summer; also by other species of Pythium and strains of soft rot bacteria.
Frogeye	*Cercospora nicotianae* Ell. & Ev.
Fusarium wilt	*Fusarium oxysporum* (Schlecht.)Wr. Var. *nicotianae* J. Johnson

TABLE 7.—*Major seedbed diseases of tobacco and their control*

Disease	General conditions	Most distinctive symptoms	Control
Anthracnose	Leaves with many small whitish spots.	Veins on the underside have red-brown streaks.	Regular spraying or dusting with carbamate[1] fungicides.
Blackfire	Leaves with dark irregular spots	Lesions tend to be angular.	Early application of copper fungicides or streptomycin[2] sprays or dusts.
Black root rot	Retarded growth	Plants wilt during the warm part of the day; roots are decayed and black.	Soil sterilization; avoid seeding on alkaline soil; use resistant varieties.
Blue mold	Leaves with large irregular dead areas.	Underleaf surface shows a downy mold growth before the tissue dies	Regular dusting or spraying with carbamate fungicides as a preventative; use gas, paradichloro-benzene (PDB), under heavy cover when disease appears; or streptomycin sprays or dusts (fig. 45).
Damping off	Plants dying in spots.	Stems at the ground surface are withered.	Soil sterilization, ventilation, and regular spraying or dusting with carbamate fungicides.
Wildfire	Leaves with rounded yellowish spots.	Younger spots have a dead light-colored center the size of a pinhead and a brown yellowish border.	Early application of fixed copper fungicides or streptomycin sprays or dusts; use resistant varieties.

[1]Carbamates may include ferbam (ferric dimethyldithiocarbamate), zineb (zinc ethylenebis [dithiocarbamate], and maneb (manganous ethylenebis[dithiscarbanate]).
[2]Streptomycin may include commercial formulations or streptomycin sulfate or nitrate. Carefully read the precautions on container labels before using chemicals.

Root lesion or meadow nematode (Brown root rot)	*Pratylenchus* spp. about 3 species occur but usually one species is important in various regions.
Root knot	*Meloidogyne* spp. At least 5 species but seldom more than 2 in the same field.
Sore shin	*Rhizoctonia solani* Kuhn.
Southern stem and root rot	*Sclerotium rolfsii* Sacc.
Stunt nematode	*Tylenchorhynchus claytoni* Steiner
Tobacco mosaic	Tobacco Mosaic Virus (TMV)
Vein banding	Potato Virus Y (PVY)
Wildfire	*Pseudomonas tabaci* (Wolf & Foster) F.L. Stevens

PN-4281

FIGURE 43.—Black shank destroyed this tobacco crop as it approached maturity.

TABLE 8.—*Major field diseases of tobacco and their control*

Disease	General conditions	Most distinctive symptoms	Control
1. Root and stalk diseases Bacterial (Granville) wilt	Wilting of entire plant	Diseased plants wilt and dark streaks extend up through stem wood instead of through pith. Plants eventually die.	Use resistant varieties and rotate with resistant or immune crops. If disease is severe, use a combination of resistant varieties, crop rotation, and soil fumigation.[1]
Black root rot	Retarded top growth and diseased roots.	Lesions on roots localized and black.	Use resistant varieties and soil fumigation and avoid transplanting on alkaline soil.[1]
Black shank	Wilting of entire plant.	Decay begins in root and extends into stalk pith; later all roots and base of stem black-6en and die.	Same as for bacterial wilt.[1]
Fusarium wilt	Plants wilt on one side.	When bark on affected side is removed, solid brown layer is on surface of the wood.	Grow resistant varieties and practice rotation with resistant or immune crops. Nematode control by soil fumigaiton reduces this disease.[1]
2. Nematodes			
Cyst	Stunted, wilted, and retarded root system.	Dark brown, oval cysts attached to the roots.	Crop rotation and soil fumigation.
Root knot	Retarded top growth and diseased roots.	Roots swollen and knotted.	Rotations, soil fumigaiton, resistant varieties.[1]
Root lesion (brown root rot or meadow)	Retarded top growth and diseased roots.	Lesions on roots red brown.	Rotation and soil fumigation.[1]
Stunt	Plants stunted and root system.	Roots are shriveled, sparsely developed, and do not elongate normally.	Crop rotation and soil fumigation.
Sore shin	Wilting of entire plant.	Dark brown stalk; decay begins at ground surface and extends up 12 to 24 inches; no sclerotia (small round bodies); affected plants scattered over the field.	No control measures known.
Southern stem and root rot	Retarded top growth and diseased roots.	Light brown stalk; decay at ground surface; sclerotia on decayed surface; affected plants scattered over field.	No control measures known.
3. Leaf diseases			
Angular leaf spot or blackfire	Leaf spots.	Lesions are irregular, angular, and dark colored.	Use more potassium and less nitrogen fertilizer, transplant healthy plants, and practice rotation.
Brown spot	Leaf spots.	Spots are rounded, red brown, and dark colored with concentric rings surrounded by a halo.	Use tolerant varieties.
Cucumber mosaic	Leaf malformation and mottling	Green and yellow mottling that is most conspicuous on young leaves; not distinguishable from tobacco mosaic in the field.	Control aphids and practice sanitation. Destroy all stalks and trash, do not use tobacco products around the tobacco General sanitation methods.
Frogeye	Leaf spots	Spots are irregular; many are paperwhite with dark dots in the center	No control measures known
Ring spot	Leaf malformation mottling.	White dead areas form concentric rings or lines that follow the veins; later, leaves show no symptoms.	Avoid growing tobacco after clover, lespedeza, and alfalfa
Streak	Leaf malformation and mottling.	Young leaves suddenly become necrotic and crumpled in appearance; later, leaves show no symptoms.	Avoid growing tobacco after or near sweet clover.

TABLE 8.—*Major field diseases of tobacco and their control (Cond't)*

Disease	General conditions	Most distinctive symptoms	Control
Tobacco etch	Leaf malformation and mottling.	Older leaves mottled; younger leaves show only chlorotic spots.	Control aphids and practice sanitation.
Tobacco mosaic	Leaf malformation and mottling	Green and yellow mottling that is most conspicuous on young leaves.	Practice sanitation, rotation, and the use of resistant varieties; spray plants with milk and wash hands with milk during transplanting.
Vein banding (potato virus Y)	Leaf malformation and mottling.	Dark green borders along veins of older leaves.	Control aphids and practice sanitation.
Wildfire	Leaf spots.	Younger spots have a small dead center and a wide yellow border.	Use more potassium and less nitrogen fertilizer, use resistant varieties, and transplant healthy plants.
1. Physiological diseases[2]			
Frenching	Leaf malformation and mottling.	Young leaves are chlorotic; older leaves become thick and strap like.	No control measures known but tobacco grown on well drained soil with good nutrient balance usually does not french.
Weather fleck	Leaf spots, chlorosis, and premature firing caused by air pollution.	Small irregular shaped lesions primarily on upper leaf surface of older leaves.	Grow the most tolerant varieties.

[1]Destruction of stalks and turning up tobacco roots as soon as harvest is complete aids in control of many soil-borne organisms for the succeeding crop.

Diseases that are not caused by a pathogenic organism.

TABLE 9.—*Major tobacco malnutritional disorders caused by nutrient deficiencies and their control*[1]

Group	Genteral conditions	Specific symptoms	Fertilizer element needed
Effects localized on lower leaves of plant.	Local mottling or yellowing, with or without brown spotting of dead lower leaves; little or no drying up of leaves.	Lower leaves mottled with dead spots at tips and margins, which are tucked or cupped under; stalk slender in extreme cases and may show dead areas; if shortage becomes acute in mature plants, top leaves may be first to show symptoms.	Potassium
		Lower leaves yellow and usually show no spots; tips and margins turned or cupped upward; stalk slender in extreme cases	Magnesium
Effects general on whole plant.	General on whole plant; yellowing and drying up or firing of lower leaves.	Plant light green; lower leaves yellow and dry to light brown; stalk short and slender if fertilizer is deficient in later growth stages.	Nitrogen
		Plant dark green; lower leaves may yellow and dry to a greenish brown to black; stalk short and slender if fertilizer is deficient in later growth stages.	Phosphorus
Effects localized on newer or bud leaves of plants.	Terminal bud dies; death is preceded by peculiar distortions at the tips or bases of young making up bud.	Young leaves making up terminal bud first typically hooked, then die back at tips and margins so that later growth of such shows a cutout appearance at tips and margins; stalk finally dies back at terminal bud.	Calcium
		Young leaves making up terminal bud first light green at base, then more or less breakdown takes place at base of young leaf; if later growth follows, leaf shows twisted growth; stalk finally dies back at terminal bud.	Boron

TABLE 9.—*Major tobacco malnutritional disorders caused by nutrient deficiencies and their control*[1] *(Cond't)*

Group	Genteral conditions	Specific symptoms	Fertilizer element needed
Effects localized on newer or bud leaves of plants.	Terminal bud remains alive; newer or bud leaves yellow, with or without dead spots; veins light or dark green.	Young leaves yellow, with dead spots scattered over leaf; smallest veins tend to remain green, producing a checkering effect on leaf; stalk slender.	Manganese
		Young leaves light green, no dead spots; veins lighter green than inter-vein tissues; stalk short and slender.	Sulfur

[1] Malnutrition disorders caused by lack of certain fertilizer elements decrease plant growth and may cause death of some parts of plant; affects plants in seedbeds and in the field. Excess of certain fertilizer elements can cause plant toxicity and stunt or actually kill the plant.

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FIGURE 44.—A, normal growth of plant when all elements are supplied. Tobacco plants showing effects due to malnutrition produced by the following plant nutrient shortages: B, nitrogen; C, phosphorus; D, potassium; E, boron; F, calcium; G, managanese.

NEMATODES

Plant parasitic nematodes are the cause of some of the major diseases of tobacco in the Southeastern United States. Soil fumigation has proven practical and effective for control.

Some soil fumigants are volatile, liquid compounds whose vapors penetrate the soil to kill nematodes. Others are nonvolatile and in granular form; since they do not vaporize, it is necessary to mix them with the soil.

Treatment does not eradicate nematodes, but reduces them enough to allow normal crop growth without measurable loss. Roots injured by nematodes are more readily invaded by disease organisms. Consequently, fumigation treatments that reduce nematodes may also reduce other diseases.

Where diseases such as black shank, bacterial wilt, fusarium wilt, or other root diseases occur in the same field with nematodes, a combination of crop rotation, resistant varieties, and fumigation is a recommended practice (fig. 45).

The effectiveness of soil treatments depends on soil, weather conditions, methods of application, and proper dosage of the chemical. The treatments are most effective when the soil is moist but dry enough to crumble in the hand and the temperature is above 60° F. Excessive amounts of chemicals may be toxic to plants and result in lower yields, injured roots, or lower quality of cured leaf.

If the waiting period between soil treatment and transplanting is too short (usually less than 2 weeks), or the soil has a high water content, tobacco roots may be damaged or plant growth stunted. On the other hand, when fumigation is properly used on nematode-infested land, yields usually are markedly increased.

Soil Preparation

In preparing for fumigation, the soil should be well pulverized and free of roots or litter that might clog the applicator. Good tilth permits good diffusion of vapors. The soil should be in good planting condition but not be too wet to plow.

Ideal weather conditions for fumigation are mild, nonwindy days when the soil temperature is 50° to 70° F. If the soil is too dry, fumigants escape before they can take effect and results are poor. Fumigants are absorbed by the soil moisture and, therefore, become most active when there is adequate soil moisture.

Type of Application

Tobacco growers usually treat soil in early spring 2 to 3 weeks before the customary planting time. When fumigants are used that may injure tobacco, the interval between treatment and planting should be up to 3 or 4 weeks if cold, wet weather of below 60° F. persists. Otherwise, fumigants might stay in the soil in amounts that would be toxic to tobacco. Extended periods of rainy weather in early spring may prevent soil treatment.

Soil fumigants may be applied in late summer and fall after tobacco is harvested, usually September to December. A disadvantage at this time is that crop residues are more difficult to dispose of and may interfere with distribution of the chemicals. Also, undecomposed plant parts sometimes contain nematodes or nematode eggs that may be protected from fumigants.

Fumigation in the fall requires extra preparation of the soil that will have to be repeated the following spring. Therefore, fumigation in the fall does not fit well into the usual farm operations because of the extra work.

Nematicides that are not toxic to plants have an advantage because they are applied in spring and extra soil preparation is avoided. Granular formulations may be applied at the same time as fertilizer just before transplanting.

Application Methods

The two principal methods used in applying soil fumigants are row treatment and broadcast treatment. The former method is most frequently used by growers and is the least expensive. With this method the row is treated in the exact location where tobacco is to be planted. This procedure fits well with field operations because a bed is left to mark the row position.

Equipment for row treatment is mounted on a tractor to treat one or more rows (fig. 46). A gravity flow system for liquids consists of a delivery tube attached to the storage tank with the lower opening attached behind a fumigation shank, or shovel, so that fumigants are

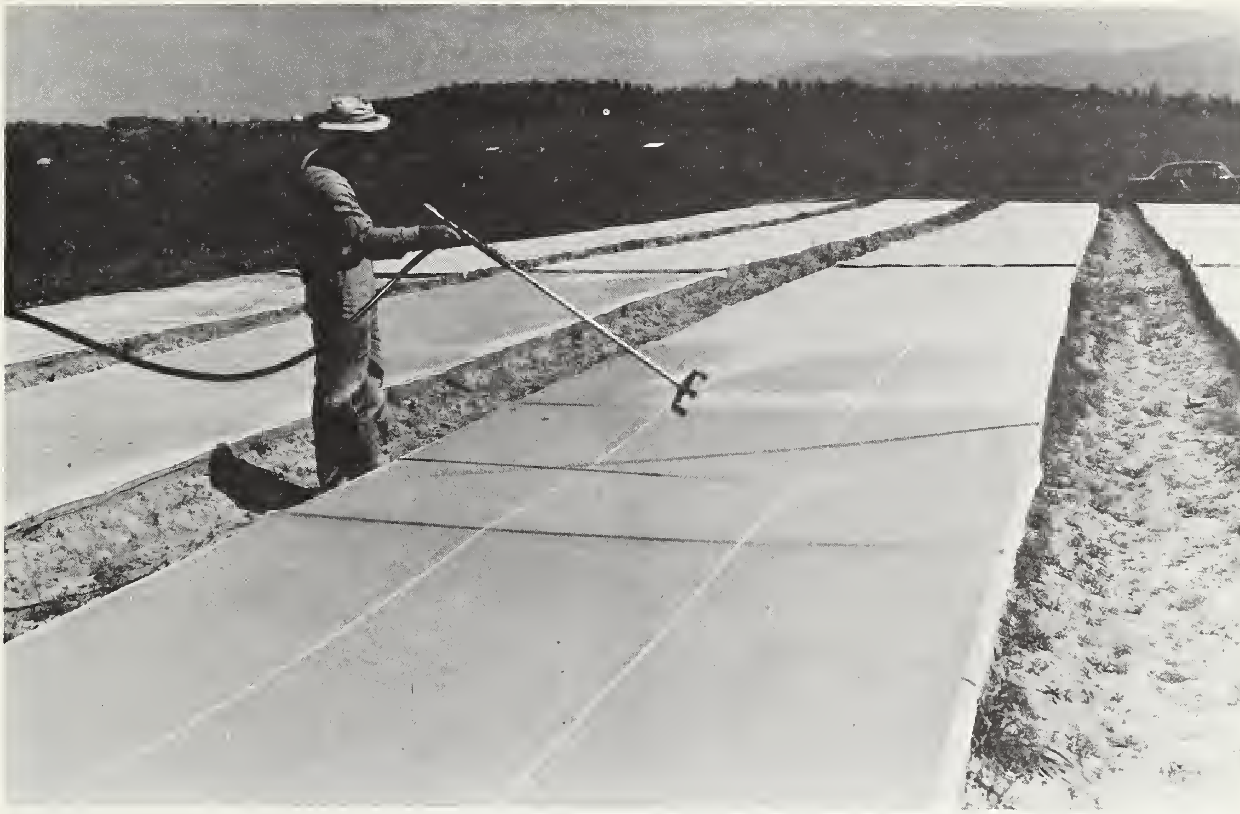

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FIGURE 45.—Spraying seedbeds for blue-mold control.

delivered at the bottom of the furrow. Details about how to adapt tractor equipment for the work is available from county agents and extension workers in the tobacco growing areas.

It is essential that volatile chemicals applied in the row be covered with soil immediately. A listed bed is thrown over the treated row by means of cultivator disks mounted behind the fumigation shank (fig. 47). The steps in row fumigation are carried on as a single operation. Sometimes the fumigant delivery tube is attached behind the fertilizer delivery shoot so that both fertilizer and fumigant may be applied at the same time.

Granular nematicides may be applied in the row with modified fertilizer distribution equipment or grain drills.

Broadcast treatments require equipment with a series of fumigation shanks arranged to treat the entire soil area in a grid pattern (fig. 48). Usually, a series of injection chisels are mounted on a cultivator bar and spaced 8 to 12 inches apart. In addition to a chemical storage tank, a broadcast rig requires a metering device, or pressure regulator; delivery tubes; and a smoothing drag or roller. Also, gravity flow applicators are available and commonly used in broadcast treatments.

Broadcast treatment is usually more effective than the row method. Because more of the soil area is treated, broadcast treatment requires more chemical and is more expensive.

Chemicals Used as Nematicides

Numerous compounds are used as nematicides. One of the soil fumigants is a chemical compound DD or DD mixture. Various formulations containing EDB (ethylene dibromide) are widely used. DD and EDB contain chlorine and bromide, respectively, which may be harmful to tobacco when too much is used. Nonfumigant types of chemicals such as ethoprop (mocap) (O-Ethyl S, S-dipropyl phosphoro-dithioate) and fensulfothion (Dasanit) (O,O-Diethyl O-[g-(methysulfinyl)] phenyl phosphorothioate) may be used.

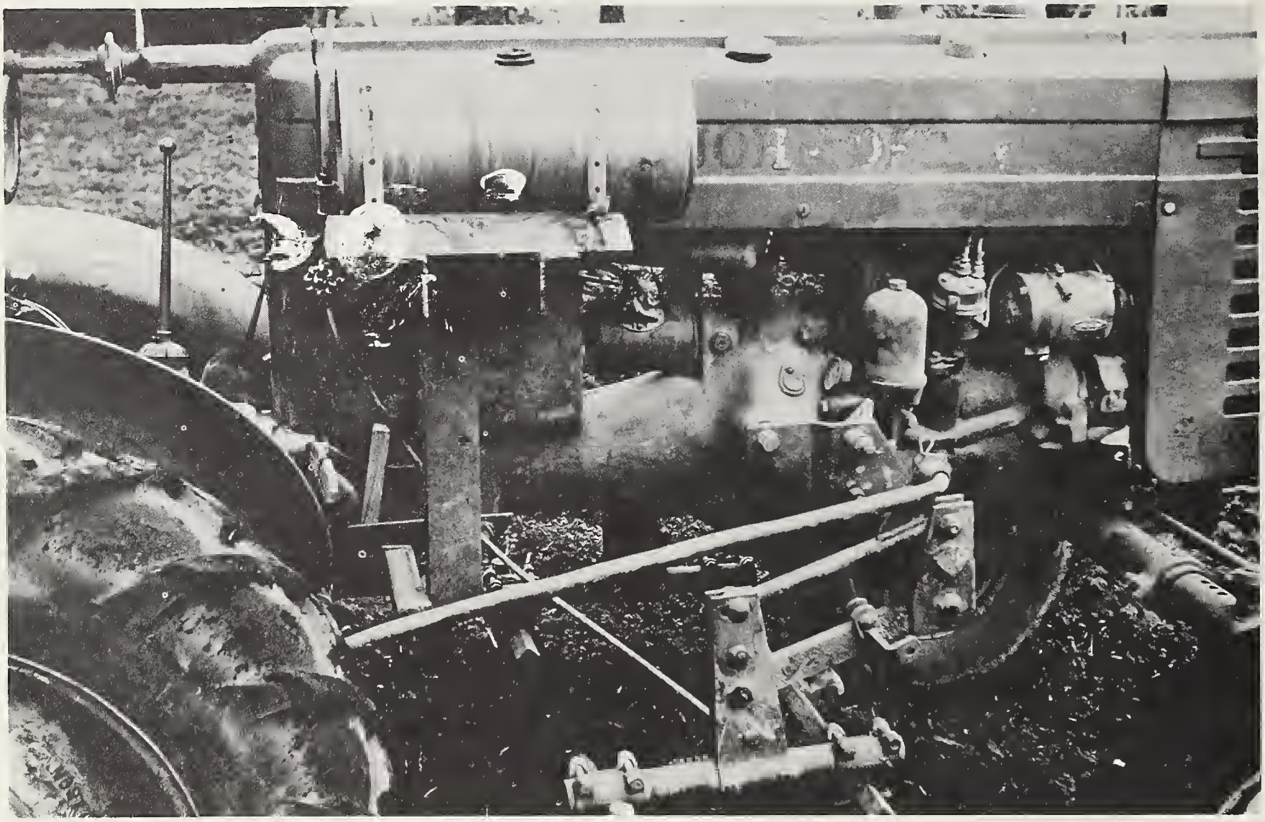

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FIGURE 46.—Fumigation application equipment mounted on a tractor for row treatment.

Accurate rates of application of nematicides. are important. Inaccurate calibration of equipmetn can be the cause of crop damage from overdosage. Nematicides to use, methods used to calibrate equipment and apply nemticides, and rates are available from county agents and in extension publications.

INSECTS AND RELATED PESTS

More than 100 species of insects have been observed feeding on tobacco in the United States. As many as 35 have caused damage requiring treatment but only five of these are serious pests. They are budworms, hornworms, flea beetles, aphids, and wireworms.

Because many insects may be observed in the seedbed or field, it is important that the grower recognize them and their potential for causing losses. Certain insects are beneficial because they feed on the pest insects that damage tobacco. Recognition of the insects present and their abundance is essential in deciding the best materials and methods to use if treatment is needed.

Wireworms, green June beetle larvae, and mole crickets work underground. They feed on roots, burrow into stems, and uproot small plants. Cutworms destroy young plants by cutting the stem near the surface of the soil.

Young budworms attack the vegetative bud, either destroying it or causing a ragged appearance as the leaves develop. Larger budworms, as well as hornworms and grasshoppers, destroy large leaf areas. Flea beetles make numerous small punctures by feeding only in small areas and aphids and suckflies suck juices from the plant leaf.

Green June beetles and mole crickets are primarily pests in the seedbed. Others in the

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FIGURE 47.—Applying soil fumigation in row application. Note the large bed to cover the fumigant.

seedbed are flea beetles and aphids and they may be transferred to the field at transplanting time.

Table 10 summarizes the more common insect pests of tobacco.

Insects Primarily in the Seedbed

Crane fly and midge.—The adults of these insects are fragile flies (figs. 49 and 50). Adult midges and full-grown larvae are only one-eighth inch long; crane flies are seven-sixteenth inch long. Midge larvae have a more distinct head, are softer bodied, and are whiter than crane fly larvae.

Larvae of both species cause damage by feeding on the roots of young plants and digging burrows in the top inch of soil (fig. 51). These insects have been serious primarily in Virginia and the Carolinas. They can be controlled with a single application of an insecticide dust.

Green June beetle.—Larvae of the Green June beetle (fig. 52) may cause damage in the seedbed by burrowing the soil and covering or uprooting small plants. These larvae are large white grubs 1½ inches long when full grown. They have the unusual habit of crawling on their back. During wet weather, they may be seen on the soil surface.

Only one generation of beetles is produced each year. Eggs are laid in June and July and the larvae continue to develop until cold weather begins. During warm weather in early spring, the large larvae become active again before pupating.

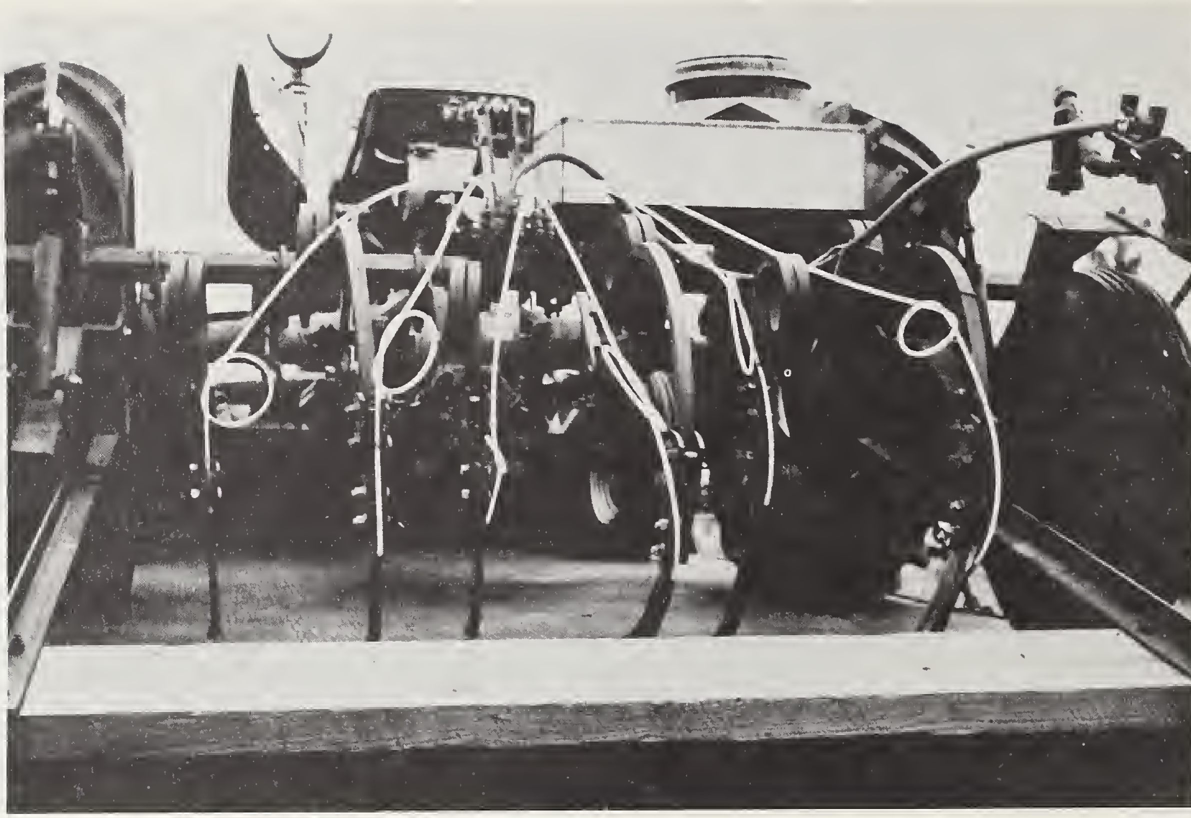

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FIGURE 48.—Soil Fumigation equipment for broadcast treatment.

TABLE 10.—*Summary of the more important insect and related pests on tobacco*

Common and Scientific Names	Description	Type of Damage
	Primarily Seedbed.	
Crane fly (*Neolimnophila ultima* (Osten Sacken))	Fragile mosquitolike adults 7/16 inch long. Larvae smooth and slender about 7/16 inch long.	Larvae feed on plant roots and dig burrows in top inch of soil.
Midge (*Orthocladius* spp.)	Adults similar to crane fly but hairy and only ⅛ inch long. Larvae slender and ⅛ inch long.	Same as crane fly.
Green June beetle (*Cotinis nitida* (L.))	Adult flat, broad, 1 inch long with green, bronze, coppery or violet markings. Larva, large white grub 1½ inches long.	Grub burrows near soil surface uprooting plants.
Mole crickets:		
Southern mole cricket (*Scapteriscus acletus* Rehn &Hebard) Northern mole cricket (*Gryllotalpa hexadactyla* (Perty))	Adults velvety brown, 1¼ inches long. Front wings short, rear wings long and membraneous. Front legs shovel-like and adapted for digging.	Burrow in top 2 inches of soil uprooting plants.
Slugs (various species)	Bodies grayish, wormlike, legless and slimy; up to 4 inches long (not insects).	Feed at night on plant leaves.
Snails	Similar to slugs but with protective shell (not insects).	Same as slugs.

TABLE 10.—*Summary of the more important insect and related pests on tobacco (Cond't)*

Common and Scientific Names	Description	Type of Damage
	Seedbed and Field	
Aphid, green peach (*Myzus persicae* (Sulzer))	Small green oval-shaped insects with or without wings. Adults ⅛ inch long. Live in clusters on underside of leaf.	Nymphs and adults such plant juices from leaves causing premature ripening; deposit cast skins and honeydew and may transmit plant diseases.
Cutworms: Black cutworm (*Agrotis ipsilon* (Hufnagel)) Granulate cutworm (*Feltia subterranea* (F.)) Variegated cutworm (*Peridroma saucia* (Hubner)) *and others.*	Moths with speckled gray wings with a 1½ inch span. Larvae dull gray, brown or black and may be striped or spotted. Larvae robust, soft bodied, smooth and up to 1¼ inches long when full grown.	Larvae cut young plants off near soil surface before feeding on foliage.
Flea beetle, tobacco (*Epitrix hirtipennis* (Melsheimer))	Adults 1/16 inch long with yellowish-brown wings with darker markings. Larvae slender and white with brown heads.	Larvae tunnel into the roots and stems of small plants. Adults feed on the leaves leaving small punctures.
Vegetable weevil (*Listroderes costirostris obliquus* (Klug))	Adults ¼ inch long with a prominent snout and a v-shaped mark on their dull grayish-brown wing covers. Larvae smooth, slender, light green and ⅝ inch long full grown.	Both larvae and adults feed on the stems and leaves of young plants.
Wireworms: Tobacco wireworm (*Conoderus vespertinus* (F.)) Southern potato wireworm (*Conoderus falli* (Lane))	Adults are click beetles ⅜ inch long. Larvae smooth, yellow-brown with definite segments and ½ inch long when full grown.	Larvae feed on roots and tunnel into the stems of young plants.
	Primarily Field	
Budworms: Tobacco budworm (*Heliothis virescens* (F.))	Moth with light, olive-green forewings with oblique white, dark olive and brown bands, wingspan 1½ inches. Full-grown larvae 1½ inches long with numerous dorsal and lateral white stripes, body usually green in color but also may be pink, red or gray.	Small larvae feed in the vegetative bud causing a ragged appearance as the leaves develop. Larger larvae feed on more mature leaves.
Corn earworm (*Heliothis zea* (Boddie))	Moth slightly larger than the tobacco budworm. Wings of males light yellowish-olive, females yellowish brown. Larvae very similar in appearance to the tobacco budworm.	Same as tobacco budworm.
Cabbage looper (*Trichoplusia ni* (Hubner))	Moth similar in size to the corn earworm but with sooty gray forewings with small hourglass figures near the center. Larvae light green, smooth and make a loop as they crawl; fullgrown larvae 1½ inches long.	Larvae feed on leaves usually on the lower half of the plant.
Grasshoppers: American grasshopper (*Schistocerca americana* (Drury)) Migratory grasshopper (*Melanoplus sanquinipes* (F.)) Redlegged grasshopper (*Melanoplus femurrubrum* (De Geer)) and others.	Adults elongated, up to 2 inches long with well developed wings and large rear legs adapted for jumping. Color may be brown, gray, black, or yellow.	Nymphs and adults are general feeders but will feed on tobacco leaves if other succulent vegetation is not available.
Hornworms: Tobacco hornworm (*Manduca sexta* (L.))	Large gray moths 2 inches long with a wingspan of 4 inches. Six large orange spots located on the sides of the abdomen. Larvae, large green worms 3½ inches long, full grown, with white diagonal stripes on the side and with a prominent red horn at the rear.	Larvae, particularly in later stages, consume large leaf areas feeding primarily on the upper 1/3 of the plant. Five or more full-grown larvae can consume an entire plant nearing maturity.

TABLE 10.—*Summary of the more important insect and related pests on tobacco (Cond't)*

	Description	Type of Damage
Tomato hornworm *(Manduca quinquemaculata* (Haworth))	Moths very similar in appearance to tobacco hornworm but have only 5 orange spots. Larvae also similar but with V-shaped markings on the side and a purple or black horn.	Same as Tobacco hornworms.
Potato tuberworm (splitworm) *(Phthorimaea operculella* (Zeller))	Small gray moths with a wingspan of ¾ inch. Larvae pinkish and ½ inch long when full grown.	Larvae tunnel into the leaves causing unsightly blotches.
Stink bugs: Southern green stink bug *(Nezara viridula* (L.))	Adults brown, green or gray, ½ inch long and shield-shaped as seen from the top.	Both nymphs and adults insert their beaks, particularly in leaf veins, to suck up plant juices causing the outward part of the leaf to wilt.
Brown stink bug *(Euschistus servus* (Say))		
Suckfly *(Cyrtopeltis notatus* (Distant))	Adults small, slender, fragile, grayish bugs about ⅛ inch long.	Suckflies may build up late in the season sucking plant juices and leaving a gummy excrement. The cured tobacco is of poor color and quality.

The adult is rather flat, green with bronze or yellow margins, and 1 inch long. It feeds on the foliage of many trees and shrubs but not tobacco. This beetle is distributed throughout the tobacco-growing region.

If present in the seedbed, the larvae can be controlled by dusting or drenching the seedbed with an insecticide.

Mole crickets.—These crickets (fig. 53) belong to the same family as the common cricket but are much different in appearance. They have large beady eyes and short, stout, shovel-like front legs for digging. The adults are 1½ inches long, brown, and covered with velvetlike hairs. The forewings are short but the rear wings are long and membraneous.

Mole crickets burrow in the upper 2 inches of soil feeding on the roots and stems of tobacco plants, uprooting them. A single mole cricket can do extensive damage in a night, covering several yards of territory.

Eggs are laid in June in earthen cells 1 to 4 inches below the soil surface. The young nymphs hatch in about 3 weeks, develop slowly, and over winter as nymphs in northern areas and as adults in Florida. In March they again become active, causing damage in the seedbed. These crickets can be controlled by dusting or drenching with insecticide.

Slugs and snails.—Although these pests are not actually insects, they usually are included in the discussion of tobacco insect pests. They are active mainly at night, eating holes in the leaves of tobacco seedlings. Before sunrise they crawl to their daytime hiding places under boards or trash, leaving slimy trails.

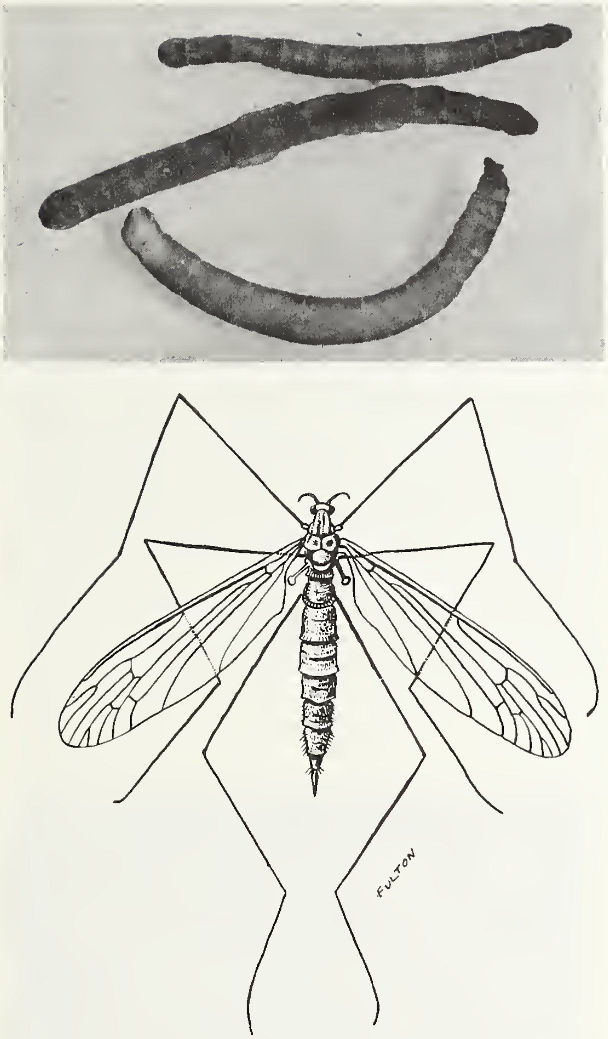
Slugs (fig 54) are usually ¾ to 1½ inches long; the diameter of a snail shell is about 1¼inches. Poisoned baits can be put around the seedbed for protection but should not be applied to the plants. If slugs and snails are active in the plant bed, they can be controlled with hydrated or air slaked lime. To avoid injury to the plants, lime should be applied only when the plants are dry.

Slugs and snails are found throughout most of the tobacco-growing area.

Insects in Seedbed and Field

Aphids.—The green peach aphid is a small green insect that feeds in colonies on the tobacco leaf and may be found throughout the tobacco-growing area. There are both winged and wingless aphids. Adults are about one-eighth inch long. The females lay living young and populations can build up rapidly.

Both adults and nymphs cause damage by sucking juices from the plant, exuding



PN-4287

FIGURE 49.—Crane fly larvae on the top and adult on the bottom. (Courtesy N.C. agricultural Experiment Station)

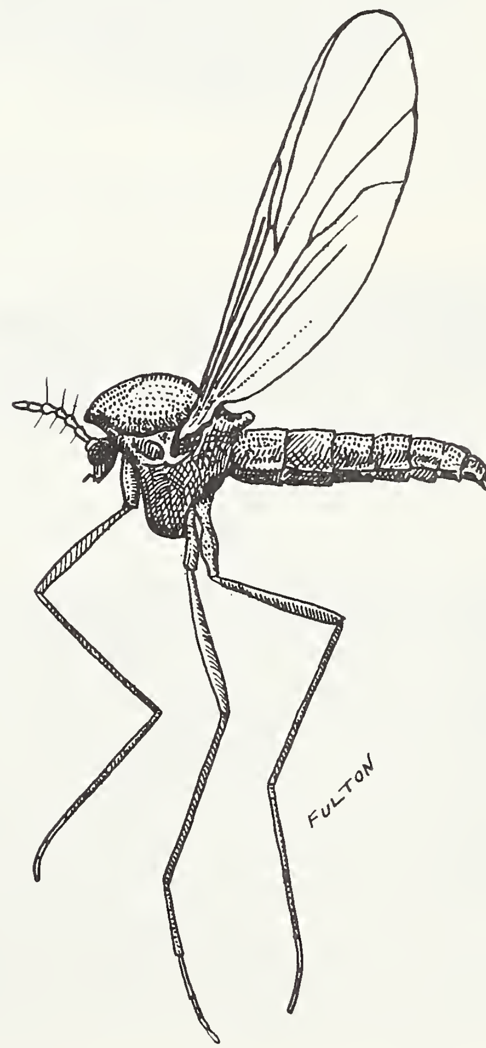
honeydew, and depositing cast skins. Premature ripening and mildew (fig. 55) that grows on the honeydew reduce the quality of the cured leaf. In addition, the aphids may transmit certain virus diseases to the plant.

Aphid infestations are sporadic and may be controlled by predators and parasites if chemicals used on the tobacco do not destroy these beneficial insects. In North Carolia and areas to the north, temperatures of 90° F. or above for several days effectively eliminate infestations. If any black or dead aphids are seen, control measures may not be necessary.

Aphids overwinter on fall-planted turnips, collards, mustard, dock, and similar plants in areas where these crops live through the winter. These plants should be removed from in and around the seedbed so aphids will not be transferred to the field at transplanting time. Systemic and foliar type insecticides are used for control.

Cutworms.—Several species of cutworms may attack tobacco in the seedbed or in the field. They are the larvae of moths and occur throughout the tobacco-growing regions. Among them are the black cutworm, the granulate cutworm (fig. 56), and the variegated cutworm.

The wings of the moths are speckled gray and



PN-4288

FIGURE 50.—Midge adult. (Courtesy N.C. agricultural Experiment Station)

PN-4289

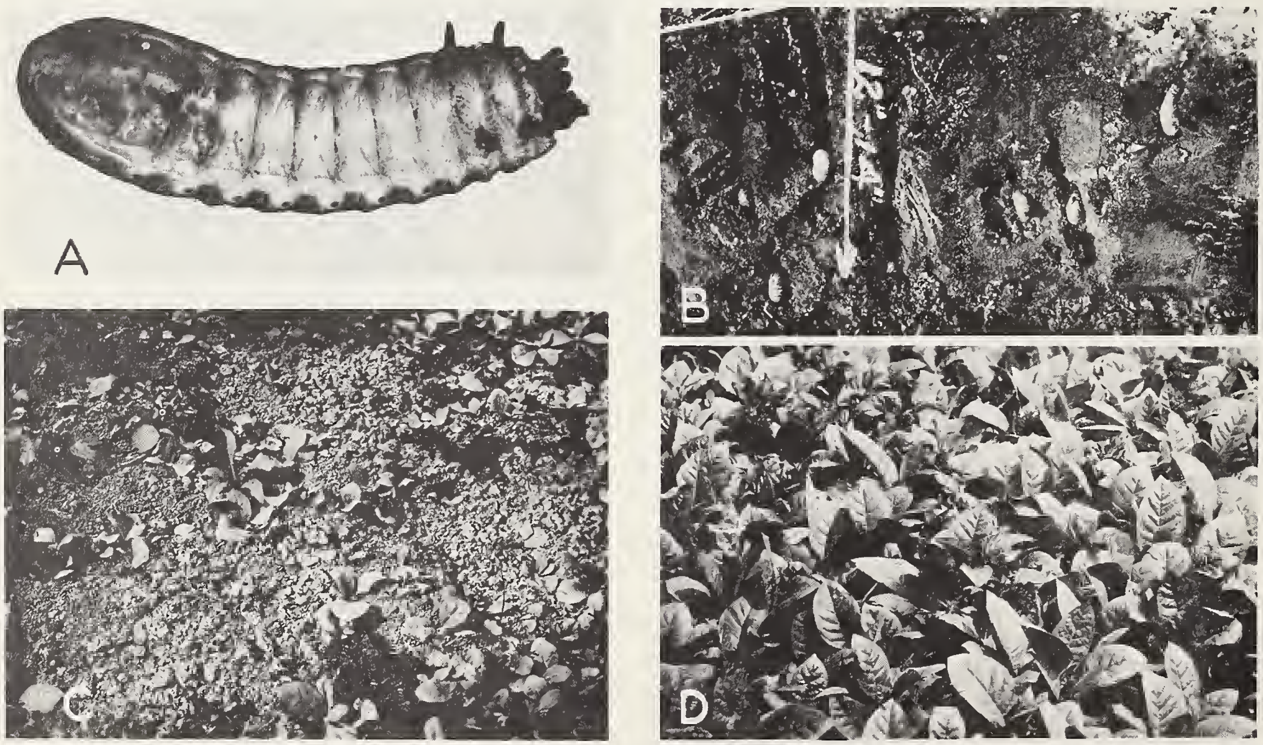
FIGURE 51.—Damage to tobacco seedlings by midge larvae. Plot on right was protected and contains abundant seedlings. The untreated plot on the left is almost devoid of plants. (Courtesy N.C. agricultural Experiment Station)

have a span of 1½ inches. They overwinter as larvae or pupae in the soil. They emerge as early as February and lay eggs on weeds that may be in the tobacco field. In Florida, cutworms may be active throughout the year.

After the weeds in the field are plowed under and the tobacco is transplanted, cutworms attack the tobacco (fig. 57). They cut the plant and allow it to wilt before feeding. The larvae feed only at night or on cloudy days.

Cutworm populations can be determined by placing tightly-packed bunches of fresh clover, dock, or chickweed on the newly-plowed field before transplanting. If present, they will collect under these clumps of vegetation within 2 to 3 days. The yellow-striped armyworm, commonly called the climbing cutworm, occasionally climbs tobacco plants and causes damage by feeding on the leaves.

Many natural controls help keep cutworms in check. The few that survive can do considerable



PN-4365 PN-4366
PN-4367 PN-4290

FIGURE 52.—Green June beetle. A, larvae about twice natural size; B, larvae in tunnels which are made below the soil surface; C, a portion of a tobacco plant bed where the plants have been destroyed by the burrowing activities of the larvae; D, plant growth on a bed where the larvae were controlled.

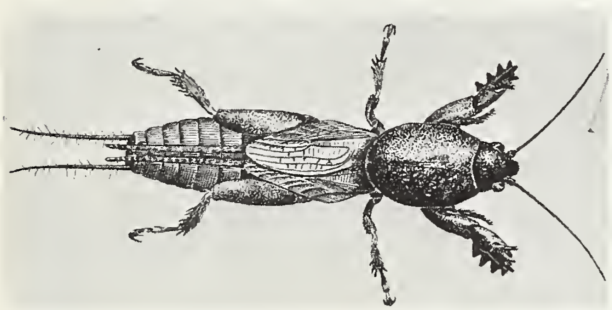
damage in sparsely planted tobacco fields. Heavy autumn rains may cause high overwintering losses of pupae. Heavy rains may also drown many larvae. Some species cannot withstand cold weather and all species suffer from abrupt changes in temperature. Many parasites, diseases, predatory insects, and spiders attack cutworms. Birds also may destroy many cutworm larvae. Plowing the soil destroys many of the cutworms overwintering as pupae.

Fumigation of the seedbed will kill existing cutworms but they can move in from other areas. Since damage can occur quickly, the seedbeds should be inspected every few days. If damage occurs, a poisoned bait may be applied around the margins of the bed, in walkways, or any open space. Application to the plants will cause burning. The same material can be used in the field if cutworms are present.

Flea beetles.—The tobacco flea beetle (figs. 58 and 59) is the most serious beetle pest on tobacco but other beetles may be present. The adults are about one-sixteenth inch long with yellowish-brown wings marked by a darker area. Adults overwinter in litter and trash around field margins. Flea beetles are found throughout the tobacco-growing areas and produce three or more generations per year.

First generation eggs are laid beneath the plant in moist soil in the seedbed. The slender larvae that hatch are white with brown heads. They tunnel into the roots and stems and feed for 4 to 5 weeks, causing the plants to be unthrifty if infestations are high.

The greatest damage usually occurs in the field from adults making tiny punctures in the



PN-4291

FIGURE 53.—Adult mole cricket.

PN-4292

FIGURE 54.—Spotted garden slug.

PN-4293

FIGURE 55.—Leaf of flue-cured tobacco. Dark areas near bottom caused by mildew growing on honeydew deposited by aphids.

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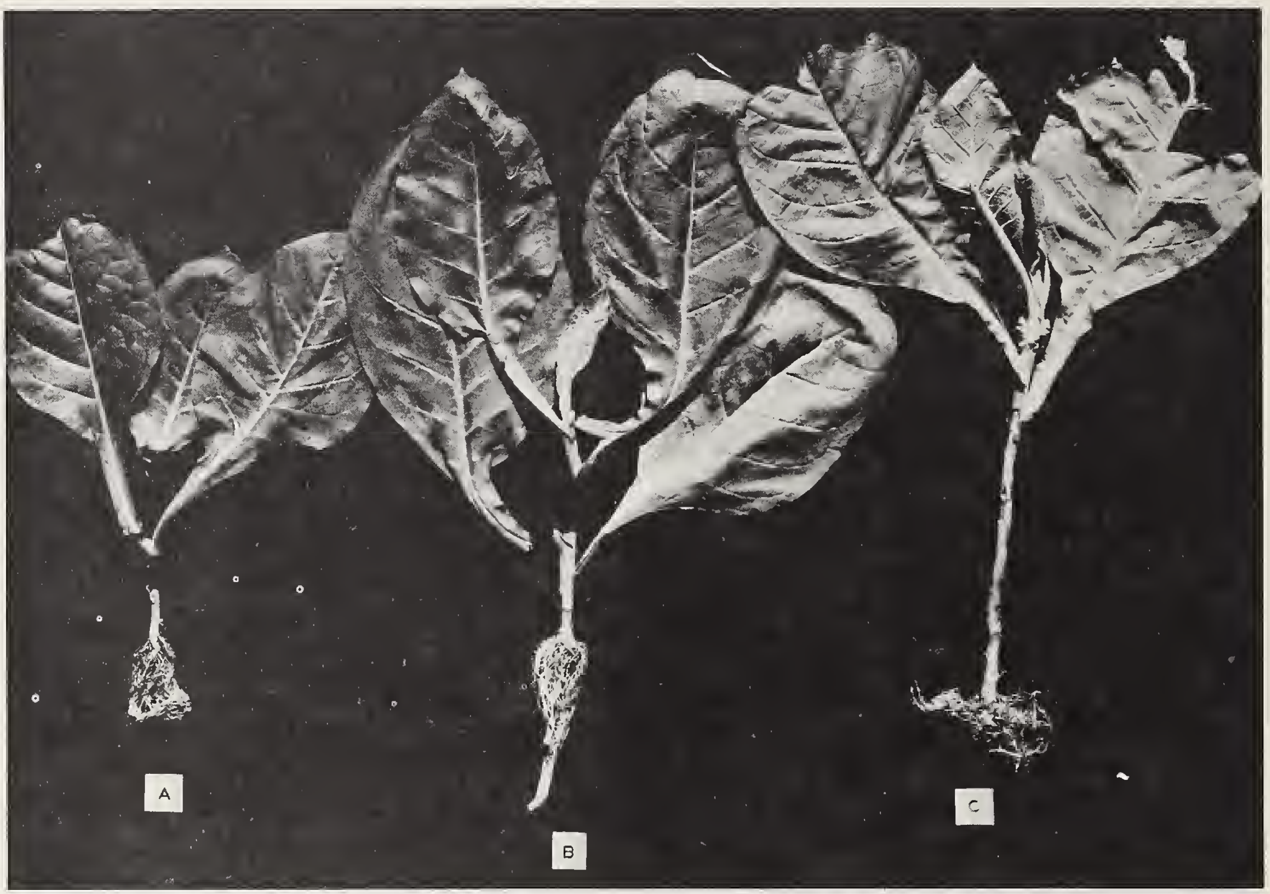
FIGURE 56.—The granulate cutworm. Moth above, larva below.



PN-4295

FIGURE 57.—Cutworm damage to tobacco plants. A, bud destroyed and stalk cut off; B, leaves and stalk cut off; C, stalk of plant severely chewed.

leaves. Toward harvest, heavy populations may build up and cause severe damage, particularly to the bottom leaves.

Flea beetles can be controlled by dusting or spraying with insecticide. Several treatments may be necessary. A systemic insecticide mixed with the soil before planting or watered in after the plants are up will protect the seedbeds until transplanting time. Systemic insecticide used in the field may protect the plants up to 6 weeks.

Natural enemies that attack flea beetles include a spider, a small parasitic wasp, a nematode, and several kinds of birds.

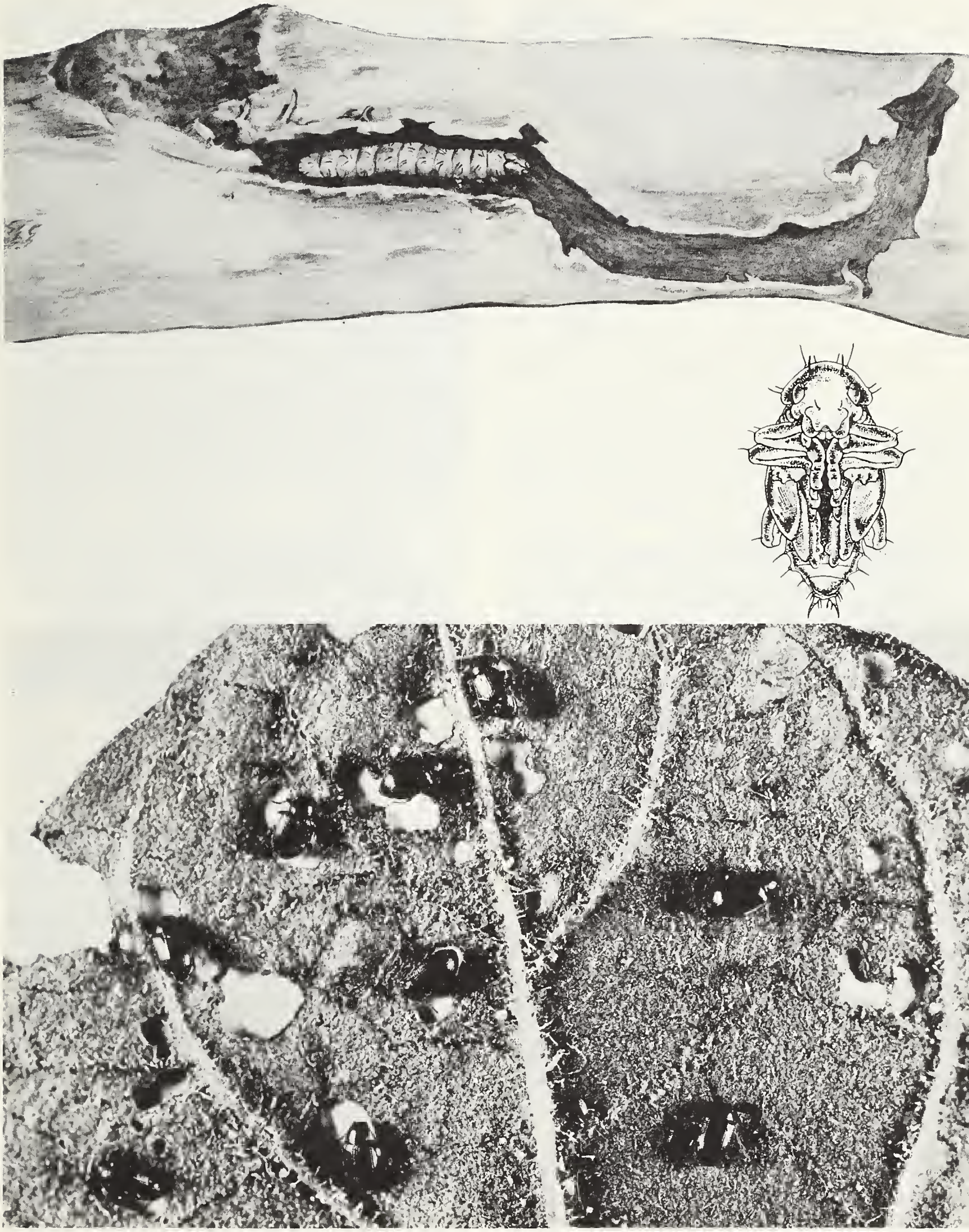
Vegetable weevil.—The vegetable weevil (fig. 60) may cause damage in the plant bed or to newly-set plants, particularly in southern areas. The adult weevils are about one-fourth inch long with a prominent snout. A V-shaped mark is on the wing covers, which are dull grayish brown.

The female lays its eggs in the fall on turnips and collards but moves to the tobacco seedbed in the spring. Larvae are green with dark mottled heads. Both larvae and adults feed on the leaves and stems of young tobacco plants. Dusts and sprays can be used to control this pest.

Wireworms.—The larvae of several click beetles attack newly set plants. Two of these are the tobacco wireworm (figs. 61 and 62) and the southern potato wireworm. These segmented, wirelike worms burrow through the soil, feeding and tunneling in plant roots and stems and killing the young plants. The adults are about three-eighths inch and full-grown larvae one-half inch long.

Pupation occurs in late spring and adults emerge during the summer. Eggs are laid in the soil and larvae feed on available vegetation until late fall. They overwinter in the larva stage. Only one generation or less occurs each year.

Wireworms may be found throughout the tobacco-growing areas but they cause more damage in the South than in the North. Where



PN-4296

FIGURE 58.—Tobacco flea beetle. Larva tunneling in stem of newly set plant (top); pupa (middle); adults feeding on small leaf greatly enlarged (bottom).

PN-4297

FIGURE 59.—Flea beetle damage to young tobacco plant.

heavy infestations occur year after year, insecticides may be broadcast 3 to 4 weeks before planting and disked 2 to 5 inches deep. For lighter infestations, the insecticide can be added to the transplant water.

Budworms.—The tobacco budworm (figs 63 and 64) is one of the most destructive insects on tobacco. The moth, two-thirds inch long with a wingspread of about 1½ inches, is light olive green with oblique white and dark olive and brown bands on the forewings.

The female is active at night depositing her eggs singly on the top and underside of the tobacco leaves. On small plants the eggs may be found near the tips of the leaves, but on half-grown plants, most of the eggs are deposited near the midrib on leaves in the midstalk position.

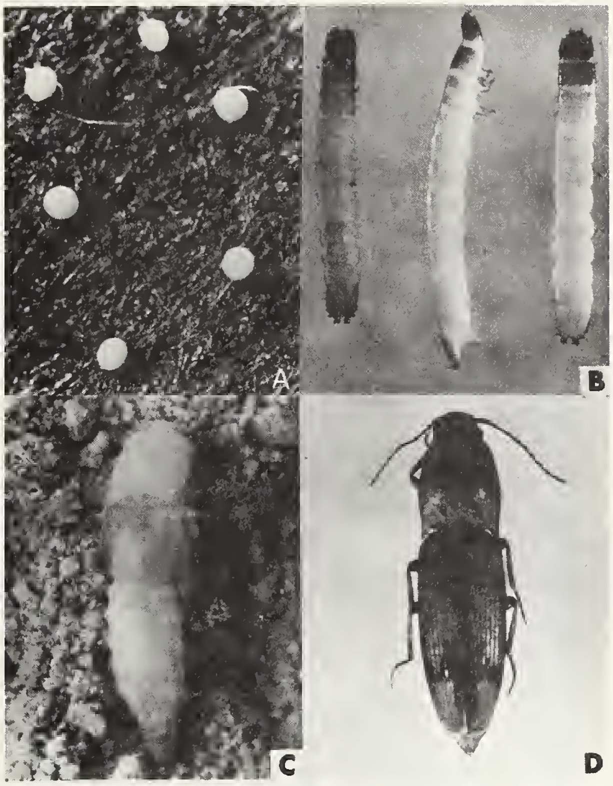
After feeding sparsely for a day or more on the leaves, the larvae enter the vegetative buds where they remain about a week. The tiny holes eaten in the buds become larger as the leaves develop, causing a ragged appearance.

While in the buds, the larvae are particularly hard to kill because the newly developed leaves are usually folded tightly against each other. To be effective, insecticide must be concentrated in the buds, and if possible, applied early in the morning or during cloudy weather when the buds are open and the larvae are likely to feed on other parts of the plant. Cornmeal bait dropped into the buds is usually more effective than spray because of its attraction to the larvae.

After the plants begin to bloom, budworms lay their eggs on the seed heads on topped tobacco and are no problem; however, if the grower is interested in seed production, he must apply an insecticide to the seed heads as well as use a protective bag. Larvae are generally dark green with whitish lines along the back and sides; however, light green, pink, red, and dark colors

PN-4368, PN-4369, PN-4298

FIGURE 60.—Vegetable weevil. Larvae (top); adult (middle); plant damage (bottom). (Courtesy N.C. Agricultural Experiment Station)



PN-4299

FIGURE 61.—Tobacco wireworm. A, eggs; B, larvae; C, pupae; D, adult. (Courtesy N.C. Agricultural Experiment Station)

are not uncommon. Color of the larvae is determined by light, temperature, food, and heredity.

Full-grown larvae are about 1½ inches long and enter the soil to pupate 1 to 3 inches below the surface. During warm weather, the next generation of moth will emerge in 12 days. In North Carolina, four generations are produced each year with the last generation overwintering as pupae. Farther south, additional generations may be produced. The tobacco budworm is not a serious pest in Virginia and farther north but from southeast North Carolina to Florida it is more serious.

The corn earworm is similar to the tobacco budworm in the damage caused and both kinds will be called budworms here unless otherwise noted. The adults are slightly larger with the forewings of the male light yellowish olive, and the forewings of the female yellowish brown. The oblique bands on the tobacco budworm are not present on the corn earworm. Larvae of the two species look so much alike that even the experts have difficulty identifying them.

In the north central part of North Carolina, few insecticides are used because budworms have been effectively controlled by an egg predator, the spined stilt bug (fig. 65). The adults eat up to 11 eggs per day. They also feed on plant juices but do not damage the plants.

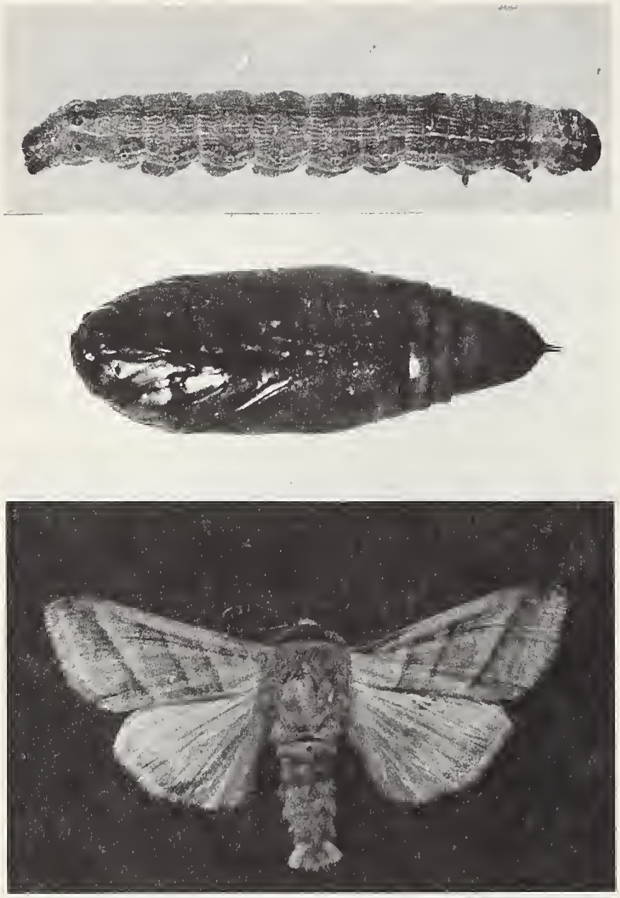
Tree crickets have an even bigger appetite, and in laboratory tests, have eaten 29 budworm eggs in one-half hour. However, the four-spotted tree cricket is a minor pest because it lays eggs in the midrib of the leaves, causing the leaves of fragile varieties to break in high wind; the beneficial activities of the cricket far outweigh any damage caused to the plant.

Certain spiders, particularly the *Peucetia viridans,* are important predators of budworm larvae, especially in the South.

A wasp, *Campoletis sonorensis,* attacks budworms when the larvae are very small. An egg is deposited in the larva and when it hatches, the wasp larva feeds on the budworm

PN-4300

FIGURE 62.—Tobacco seedlings damaged by wireworms. Plants on left have been cut to show larvae tunneling in stems. (Courtesy N.C. Agricultural Experiment Station)



PN-4371, PN-4372, PN-4301

FIGURE 63.—Tobacco budworm. Larvae (top); pupa (middle); adult (bottom).

host until about one-fourth grown. The parasitic larva soon consumes all but the outer skin of the host and crawls out to spin a cocoon and pupate on the tobacco leaf.

A larger wasp, *Cardiochiles nigriceps* (fig. 65), is common in tobacco fields searching for a host. It may deposit an egg in the corn earworm but the egg cannot develop there. However, it parasitizes the tobacco budworm, permitting the budworm to become half-grown. At this stage, the budworm enters the soil as if to pupate but the wasp larva kills the budworm and spins a cocoon in the budworm's cell in the soil.

Several kinds of parasitic flies of the family *Tachinidae* attack budworms and develop after the budworms have pupated.

Budworms usually are not active early enough to attack plants in the seedbed but they attack plants in the field. Tobacco stalks and roots should be destroyed as soon as possible after harvest to reduce the food supply of the larvae and to kill the pupae already in the soil. In field tests, fall plowing killed about 90 percent of the corn earworms overwintering in the soil.

Cabbage looper.—The cabbage looper (fig. 66) recently has been the most serious pest of shade-grown tobacco in Florida because of its resistance to most insecticides. It is seldom a serious pest in more northern areas but it may cause some damage in Georgia and South Carolina.

The moth is about the size of the corn earworm but the forewings are sooty gray with small hourglass figures near the center. It is active at night.

The larvae are found near the bottom of the plants. They are light green, rather smooth, and form a loop when they crawl. When full grown, they spin a cocoon and pupate on a tobacco leaf. They do not feed in the buds as do budworms but they damage mature leaves, causing a ragged appearance.

Although the precise areas of overwintering for the cabbage looper are not known, the first generation larvae in central North Carolina are from immigrating moths. Five or more generations may occur each year.

In addition to predators that feed on its eggs, the cabbage looper may be attacked by a parasitic wasp, *Voria ruralis,* that develops within the host's body. A naturally occuring virus disease may also help keep larvae under control.

PN-4302

FIGURE 64.—Budworm damage to young tobacco plant.

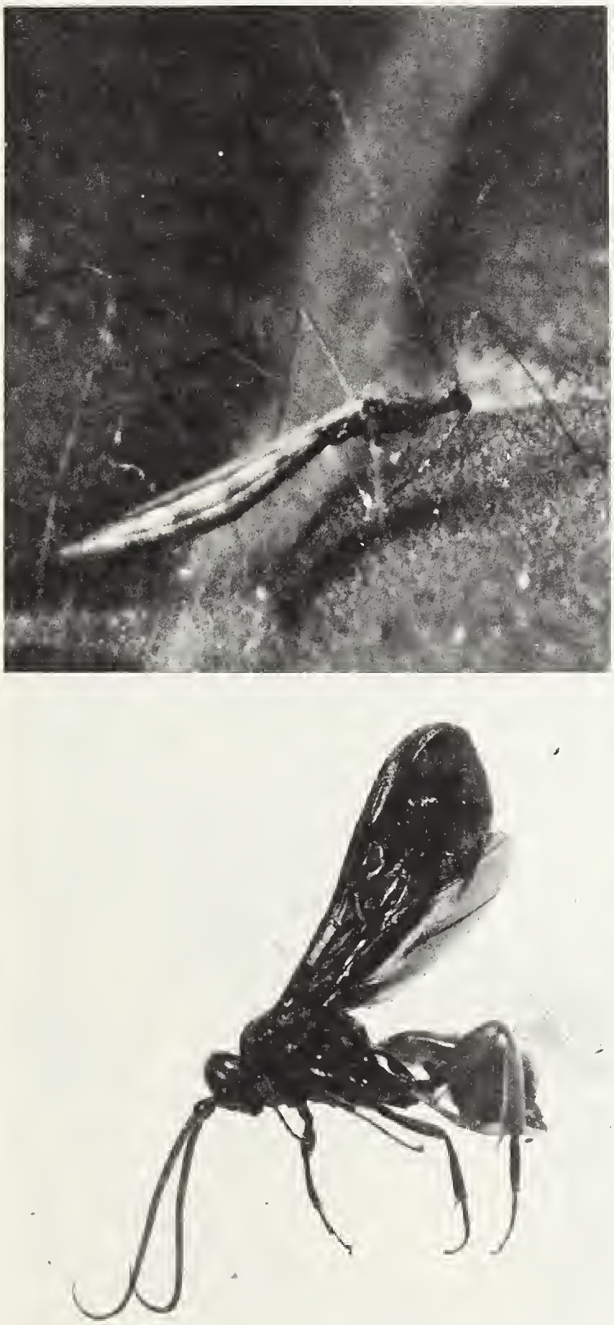
Grasshoppers.—Various grasshoppers may occasionally attack plants in the seedbed after the cover is removed. Grasshoppers are elongated insects up to 2 inches long with well-developed wings and hind legs adapted for jumping. Large areas may be eaten in the leaves. Damage is greater in the field but is usually restricted to the borders.

The best control is to apply insecticide to the seedbed or the borders of the field while the grasshoppers are still small and before they move into the field. Grasshoppers prefer other tender plants than tobacco if they are available.

In the fall, adult grasshoppers lay their eggs just below the soil surface in podlike structures. The tiny nymphs look like adults and emerge in the spring to begin feeding on almost any foliage available. Grasshoppers are found throughout the tobacco-growing area. Except in the extreme South, only one generation is produced each year.

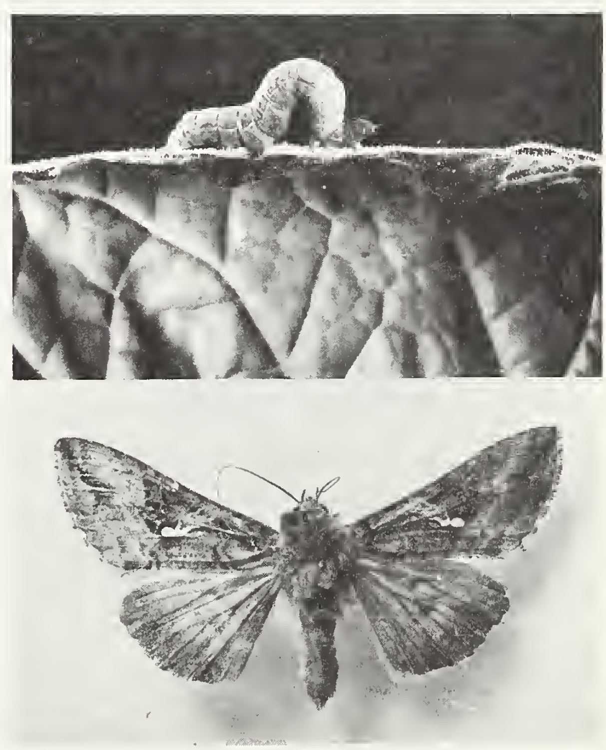
Natural controls include several bacterial diseases that kill large numbers of grasshoppers during extended periods of damp weather and several predators that develop in the egg pods.

Hornworms.—Hornworms are the most familiar of the tobacco insect pests. The tomato hornworm is found primarily in North Carolina and other States to the north but usually it is not



PN-4373 PN-4303

FIGURE 65.—Natural enemies of the tobacco budworms. Spined stilt bug, an egg predator (above); *Cardiochiles nigriceps*, larval parasite (below).



PN-4374, PN-4304

FIGURE 66.—Cabbage looper. Full-grown larva (top); adult (bottom). (Courtesy N.C. Agricultural Experiment Station)

a serious pest except in extreme northern areas. The tobacco hornworm (figs. 67, 68, 69, and 70) is a serious pest in North Carolina and other States to the south. The tobacco hornworm is a serious pest because of its ravenous appetite but the use of chemicals make it easier to control than the budworm.

Both the tobacco and tomato hornworm moths are about 2 inches long with a wingspan of 4 inches. The tobacco hornworm has a row of six prominent orange spots along the sides of the abdomen and the tomato hornworm has five.

A female may lay 1,200 or more eggs during her lifetime but the same egg predators that attack budworms also attack hornworms and may help keep them in check. Most tobacco hornworm eggs are laid on the underside of the leaves near the leaf margins in the upper third of the plant. They are large eggs about one-sixteenth inch in diameter and hatch in about 4 days.

The newly-hatches, yellow larvae eat small patches of leaf. As they become larger, they eat larger sections of leaf. About 90 percent of the total damage takes place just before the larvae mature. Five or more larvae can defoliate a full-grown plant.

The young larvae develop a green color soon after feeding begins and as they mature, white diagonal stripes develop on the tobacco hornworm and V-shaped markings on the tomato hornworm. The horn is a narrow spike at the rear of the worm and usually is red on the tobacco hornworm and purple on the tomato hornworm.

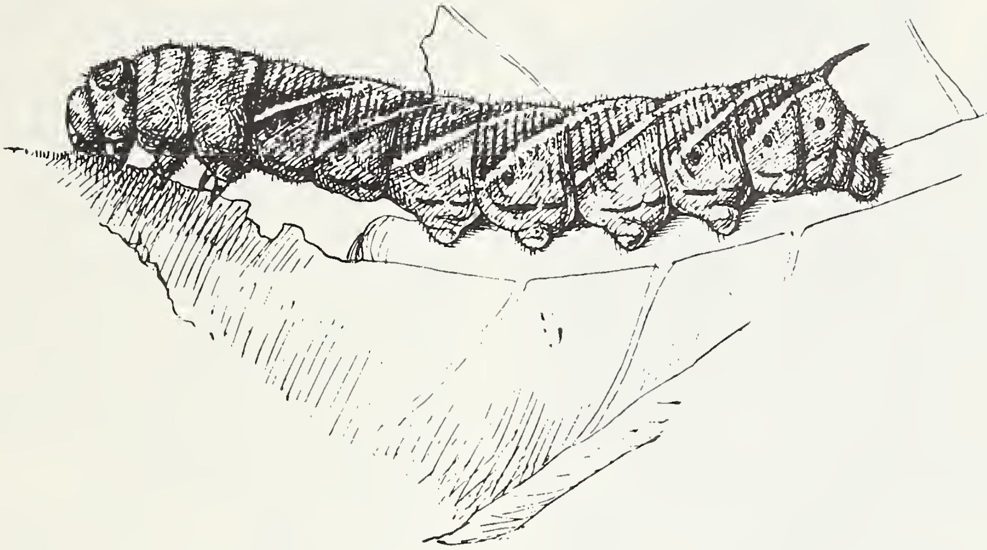
Full-grown larvae are 3½ inches long and weigh 9 to 12 grams. They burrow into the soil usually to the plow sole and build a cell about the size of a lemon. In about 4 days they shed the last larval skin to pupate.

Besides egg predators, other natural enemies attack hornworms. A small wasp, *Apanteles congregatus,* deposits its eggs in the hornworms while they are still very small. Before the hornworm larvae mature, as many as 300 wasp larvae may have developed. They burrow through the cuticle, attach themselves to the body of the host, and spin small white cocoons in which they pupate and develop into new generation of wasp adults (fig. 71).

Certain larger wasps, such as the yellow jacket, cut up large hornworm larvae and carry them bit by bit to their nests to feed their young. Birds occasionally destroy entire field populations of hornworms.

PN-4305

FIGURE 67.—Tobacco hornworm adult.



PN-4306

FIGURE 68.—Tobacco hornworm larva.

PN-4307

FIGURE 69.—Tobacco field completely destroyed by hornworms.

PN-4308

FIGURE 70.—Closeup of almost full-grown tobacco hornworm larvae feeding on tobacco.

If the hornworm larvae escape previous hazards, they may be attacked by tachinids (parasitic flies). Tachinids permit the larvae to enter the soil and pupate but prevent their development into moths.

Cutting stalks promptly after harvest or the use of sucker-control chemicals may greatly reduce overwintering hornworms through destruction of their food supply. Plowing down to the previous plow soil may destroy up to 90 percent of the hornworms that have entered the soil.

If hornworm larvae are not too numerous, it may be convenient to handpick them during the growing season, particularly when the tobacco is topped and suckered. If insecticides are used, they should be applied sparingly to the upper six leaves of the plant where most of the larvae are found.

Potato tuberworm.—This insect is also known as the splitworm and is primarily a pest of the Irish potato. However, if tobacco is grown in rotation with potatoes or potatoes are stored near the tobacco field, it may also infest tobacco (fig. 72).

The adult is a small, gray moth with a wingspread of three-fourths inch. The small, pinkish larvae tunnel into the leaves to feed and are one-half inch long when full grown. About five generations are produced each year. Insecticides can be used for control.

Stink bugs.—Stink bugs occasionally cause damage throughout the major tobacco-growing areas. Adults are brown, green, or gray, one-half inch long, and shield-shaped as seen from the top. The eggs are laid in tight clusters on the underside of the leaves. The newly hatched nymphs resemble adults in appearance.

They become adults in a few weeks, feed throughout the season, and overwinter as adults. Both nymphs and adults stick their beaklike mouth parts usually into the leaf veins, causing the other portions of the leaves to wilt and turn brown. Stink bugs are controlled in the same manner as hornworms.

Suckfly.—This is a very small, fragile, grayish insect (figs. 73 and 74) one-eighth inch long with long legs and antennae. Occasionally,

PN-4309

FIGURE 71.—Hornworm larvae parasitized by *Apanteles congregatus*.

PN-4310

FIGURE 72.—Potato tuberworm (splitworm) larvae feeding on tobacco leaf.

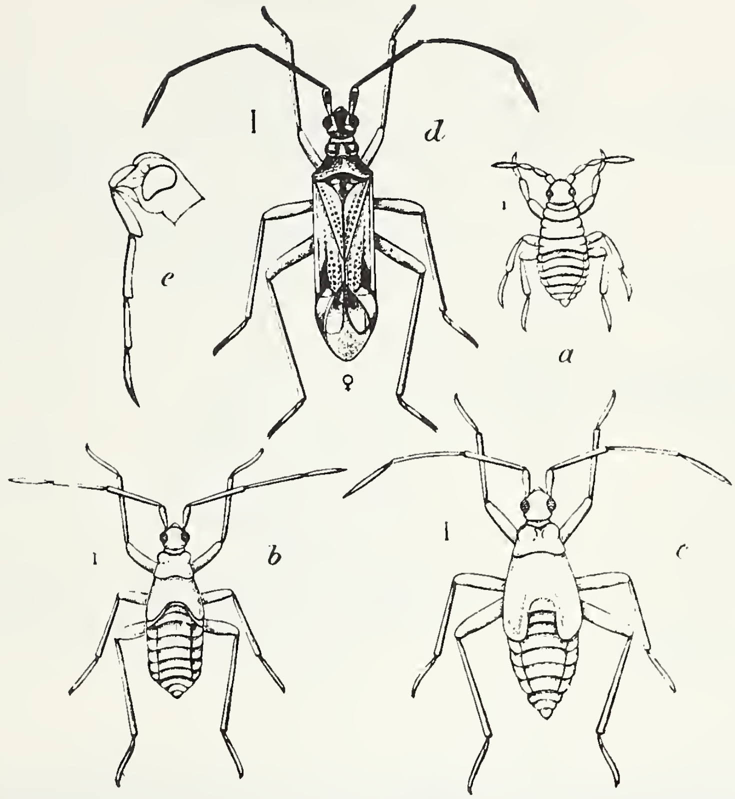


FIGURE 73.—Suckfly. A, newly hatched; B, second stage; C, nymph; D, adult; E, head and beak from side.

it builds up into large numbers late in the season, sucking plant juices from the leaves, depositing small black specks of excrement, and causing the leaves to bleach. The tobacco has poor color and quality.

Suckfly is easily confused with a beneficial insect of the same genus. When necessary, suckfly can be controlled with insecticide.

Chemical Control of Insects

Chemicals approved for insect control change yearly because the insects develop resistance to them, new restrictions are placed on their use, or safer and more effective materials are developed. Chemicals currently being used on the major pests in the seedbed and field and recommendations for use are listed in tables 11, 12, and 13. However, because of changes in registration and variations among State recommendations, the local county agent or State extension personnel should be consulted before using any of these materials.

Insecticides should be applied only as needed. Weekly inspections of tobacco fields should be made where possible instead of applying insecticides on a preventive basis. Chemicals should not be used unnecessarily because of (1) increased production costs; (2) hazards to the applicator; (3) hazards to those working in the field; (4) kill of beneficial insects; (5) residues on the tobacco; and (6) contamination of the environment.

If lepidopterous pests (budworms, hornworms and loopers) are the primary pests requiring control, *Bacillus thuringiensis* (Berliner) has several important advantages over the conventional insecticides. It is a natural disease organism specific for this group of pests and has none of the disadvantages listed above other than cost.

Spraying Methods.—The tobacco plant is more sensitive to chemicals than most other crops and occasionally foliage and bud injuries occur. These can be minimized by (1) not using carbaryl (Sevin) on seedbeds or newly set plants; (2) avoiding overdoses of granules,

TABLE 11.—*Major insects in seedbed*

Insect	Insecticide	Formulation[1]	Where and When to Apply	Remarks and Precautions
Aphid, green peach *(Myzus persicae)*	Acephate (Orthene)	SP	On foliage as needed	Destroy collards, cabbage, wild mustard and dock within 50 yd of seedbed to avoid overwintering of aphids.
	Disulfoton (Di-syston)[2]	G	Work into top 2 in. of seedbed before seeding or water in after plants are up	
	Endosulfan(Thiodan)[2]	D or EC	On foliage as needed	
	Malathion	EC		
	Parathion[2]	D, EC or WP		
Flea Beetles	Disulfoton (Di-syston)[2]	G	As for aphids	
	Parathion[2]	D or WP	On foliage as needed	
Grasshoppers	Malathion	D or WP	On foliage as needed and 2 yd. strip outside seedbed	
Mole crickets	Parathion[2]	WP	Sprinkle uprooted area in seedbed	
	Trichlorfon (Dylox)	B	Mix with wheat bran and apply late afternoon to open areas in and around seedbed	Do not apply to plants or burning will result; use protective gloves.
Vegetable weevil *(Listeroderes Costriostris obliquus)*	Disulfoton (Di-syston)[2]	G	As for aphids	
	Parathion[2]	D or WP	On infested plants	

[1]SP=soluble powder; G=granules; D=dust; EC=emulsifiable concentrate; WP=wettable powder; and B=bait.

[2]THESE MATERIALS ARE HIGHLY TOXIC AND SHOULD BE USED ONLY BY TRAINED PERSONS WHO WILL READ AND FOLLOW DIRECTIONS ON THE LABEL. (Malathion will give fair control of aphids and flea beetles)

TABLE 12.—*Major insects on newly set plants*

Insect	*Insecticide*	*Formulation[1]*	*Where and When to Apply*	*Remarks and Precautions*
Aphid, green peach *(Myzus persicae)*	Acephate (Orthene)	Sp	On foliage as needed	
	Carbofuran (Furadan)[3]	G	Work into top 4-6 in. of soil prior to transplant.	May cause yield losses.
	Disulfoton (Di-syston)[3]		Broadcase or 12-18 in. over row.	
	Parathion[3]	D,EC or WP	On foliage as needed	
	Malathion	D or EC		
	Monocrotophos (Azodrin)[3]	Soln.		
	Endosulfan (Thiodan)[3]	EC		
Budworms (Heliothis spp)[2]	Acephate (Orthene)	SP	On plant as needed	
	Bacillus thuringiensis (BT)	B	Drop pinch on bud or use hand or power duster.	Baits are far superior to sprays when worms are in the bud. BT is harmless to workers and beneficial insects.
	Carbaryl (Sevin)	WP	On plant as needed	Repeated use may cause buildup of aphids. Do not use on poorly established plants.
	Carbofuran (Furadan)[3]	G	As for aphids	
	Endosulfan (Thiodan)[3]	EC	On plant as needed	
	Methomyl (Lannate) (Nudrin)[3]	SP or Soln.		
	Monocrotophos (Azodrin)[3]	Soln.		
	Methidathion (Supracide)[3]			
	Trichlorfon (Dylox)	B	As BT Above	
Cutworms	Trichlorfon (Dylox)	B	Scatter bait in field near plants late afternoon.	Best results if field is baited before transplanting.

TABLE 12.—*Major insects on newly set plants (cond't)*

Insect	*Insecticide*	*Formulation*[1]	*Where and When to Apply*	*Remarks and Precautions*
Flea beetles	Acephate (Orthene)	SP	On foliage as needed	
	Azinphosmethyl (Guthion)[3]	EC		
	Carbofuran (Furadan)[3]	G	As for aphids	
	Disulfoton (Di-syston)[3]	G		
	Monocrotophos (Azodrin)[3]	Soln.	On foliage as needed	
	Parathion*	EC or WP		
	Methidathion (Supracide)[3]	EC		
Wireworms	Carbofuran[3]	G	As for aphids	
	Diazinon[3]	WP	Apply in transplant water.	Do not mix with fertilizer solution.
	Fensulfothion(Dasanit*)	EC or G	Broadcast or spray on soil at least 3 weeks prior to transplanting; work into top 6-9 in.	Do not mix with fertilizer granules.
	Diazinon[3]	EC or G		
	Dyfonate[3]	G		
	Ethnoprop (Mocap)[3]	G		
	Parathion[3]	G		

[1] SP=soluble powder; G=granules; D=dust; EC=emulsifiable concentrate; WP=wettable powder; B=bait; Soln.=solution.

[2] Treat only if 5 or more plants out of 50 infested.

[3] THESE MATERIALS ARE HIGHLY TOXIC AND SHOULD BE USED ONLY BY TRAINED PERSONS WHO WILL READ AND FOLLOW DIRECTIONS ON THE LABEL.

PN-4312

FIGURE 74.—**Suckfly damage to tobacco leaf.**

TABLE 13.—*Major insects on established plants in field.*

Insect	Insecticide	Formulation[1]	Where and When to Apply	Remarks and Precautions[2]
Aphid, green peach *(Myzus persicae)*	Same as for aphids on newly set plants			Hot weather may kill aphids. Withhold treatment if dead or dying.
Budworms *(Heliothis* spp)	Same as for budworms on newly set plants		Treat only if 5 or more plants out of 50 infested. Cease treatment prior to buttoning. (Does not apply if seed is produced or on cigar wrapper tobacco).	
Flea beetles	Same as for flea beetles under newly set plants or: Carbaryl (Sevin)	 D or WP	 Cover entire plant as needed	 Repeated use may cause aphid buildup.
Grasshoppers	Carbaryl (Sevin)	D or WP	Treat field borders and nearby vegetation preferably when insects are small.	
	Malathion Methomyl (Lannate)[3]	EC Soln. or WP		Treated vegetation should not be harvested or fed to livestock within 7 days of treatment.
Hornworms *(Manduca* spp)	Acephate (Orthene) *Bacillus thuringiensis* *Carbaryl (Sevin)* Azinphosmethyl (Guthion)[3] Methidathion (Supracide)[3] Methomyl (Lannate) (Nudrin)[3] Monocrotophos (Azodrin)[3]	SP Soln. or WP D or WP EC EC Soln. or WP Soln.	Concentrate material on top 1/3 of plant when 5 or more hornworms 1 in. or longer are present per 50 plants.	If treatment needed during harvest apply immediately after rather than before priming.

[1]SP=soluble powder; G=granules; D=dust; EC=emulsifiable concentrate; WP=wettable powder; B=bait; Soln.=solution.

[2] Dry gloves and tightly woven clothing required if workers enter fields within 5 days of treatment with the following materials:

Azinphosmethyl	Monocrotophos	Methomyl
Methyl parathion	Parathion	
Endosulfan (1 day)		

Minimum days from last application to harvest:

	Priming	Cutting
Methidathion	3	3
Methomyl	7	14
Monocrotophos	5	-
Parathion	5	15

[3] THESE MATERIALS ARE HIGHLY TOXIC AND SHOULD BE USED ONLY BY TRAINED PERSONS WHO WILL READ AND FOLLOW DIRECTIONS ON THE LABEL.

dusts, sprays, or baits; (3) keeping all nozzles at least 12 to 18 inches from the bud and foliage; (4) adjusting nozzles for uniform spray pattern; (5) avoiding leaks in the spray equipment; (6) using a spray pump with sufficient capacity to force enough liquid through the by-pass to keep insecticides and water well mixed; (7) using at least 25 gallons of water per acre for large plants, applied at 60 pounds pressure; and (8) not mixing incompatible materials.

If spraying equipment is used for other crops to apply chemicals not registered for tobacco, any excess material should be removed and the sprayer thoroughly cleaned. Drift from sprays of these materials on nearby crops should be avoided. Chemicals that must not be used on tobacco include aldrin, BHC, DDT, dieldrin, endrin, heptachlor, TDE, and toxaphene.

Generally, 10 percent or more of the tobacco plants must be infested with budworms of any size and/or large hornworms, 1 inch or longer, to justify the cost of control. If parasites are present that interrupt feeding early in the larval stage of the pests, even higher rates of infestation can be tolerated. An exception is cigar wrapper tobacco in which even the slightest insect feeding greatly decreases the value of the leaf.

Frequency of insecticide applications

Frequency of needed insecticide applications in the major tobacco-growing areas after transplanting tends to increase from north to south. In northern areas of North Carolina, few or no treatments are needed. About two treatments are needed in central North Carolina, increasing to four or more in South Carolina. Almost weekly applications may be needed in Florida on cigar wrapper tobacco.

In northern and central North Carolina, the spined stilt bug, an egg predator, is important in controlling hornworms and budworms. It appears in the field as soon as the moths lay their eggs and is abundant throughout the season in most fields. Insecticides are used only sparingly and the most popular material carbaryl (Sevin), is not harmful to this beneficial insect.

Farther south, the stilt bug appears too late and too scattered to give adequate control and insecticides used in these areas depress stilt bug populations for 1 to 3 weeks after application.

In northern areas, cold winter temperatures reduce insect populations. Farther south, longer growing periods permit more generations per year that result in higher insect populations.

Fumigation of the seedbed

Fumigation of the seedbed for disease and weed control also reduces insect pests on or near the soil surface. A properly constructed seedbed with boards or poles well fitted and banked and a properly fitted cover will help keep insects out of the seedbed. If solid plastic covers are used and it is necessary to open the ends of the seedbed for ventilation, these openings should be covered with a fine screen to prevent entry of insect pests.

After transplanting, the seedbed usually should be destroyed to keep aphids, budworms, hornworms, flea beetles, and other tobacco pests from breeding. This may not be desirable if infestations are light and large numbers of beneficial insects are reproducing in the area and other problems such as plant diseases are not a factor.

Trapping

Traps equipped with blacklight and installed three per square mile in large or isolated areas have shown promise in helping control hornworms, particularly in low population areas. These traps reduce populations about 30 percent per year allowing a gradual decrease in the use of insecticides and subsequent buildup of beneficial species which aid in the control not only of hornworms and budworms, but other tobacco insect pests. An important adjunct to this program is early destruction of stalks and roots after harvest to limit food for overwintering pests.

IRRIGATION

Adequate soil and air moisture are necessary for the growth of leaf tobacco that will meet commercial demands. The cured leaf must possess a definite combination of shape, size, structure, elasticity, veination, color, and chemical composition that determines aroma, taste,and other qualities.

The fire-holding capacity of the cured leaf is determined by the leaf structure and its chemical composition. These properties are influenced by soil moisture, which determines in part the ability of the plant to absorb nutrients and, thus, the growth of the plant.

The adaptability of dry-season tobacco will differ widely from that of wet-season tobacco for manufacturing purposes. Cured leaf produced during a dry season may show rin burn (fig 75) and is usually small, dark, and dull in color; high in nicotine; and lacking in elasticity.

Dry-season tobacco has more aroma, which is caused by gums and resins; has a dense structure that gives it high weight per unit area; has low fire-holding capacity; and shows a slow and inactive fermentation when bulked or packed.

Soil moisture, atmospheric humidity, shading

PN-4313

FIGURE 75.—Tobacco leaf showing dry-weather damage known as drought spot; rim burn and large red-brown spots appear between the lateral veins, especially on the lower leaves of the plant.

caused by cloudiness, and air movement that increases evaporation—all help control plant growth and development. Organic matter and minerals that affect the physical condition of the soil and control moisture in the soil also are highly important to growing plants.

In dry weather, fields may be irrigated just after transplanting. On hot, sunny, or windy days when transplants are severely wilted, it is better to wait until night or early morning when the plants are standing up before applying irrigation water.

After a stand is established, irrigation is delayed for 4 to 6 weeks to encourage root development. Water may be supplied by the gravity-flow method but this method can be used only under certain conditions of soil texture and slope. Soil for the gravity-flow method must be porous and well-drained sand or sandy loam and the slope should be enough for the water to run down the row and not puddle. Water may also be applied by overhead sprinklers, which is the more widely used method (fig. 76). Irrigation is needed during dry periods when natural rainfall is insufficient.

Excessive water can damage the crop because of waterlogged soil (fig. 77). Light waterings lessen the hazard from a heavy rainfall that might follow immediately after irrigation. Excess water may cause leaching of plant nutrients from light soils and stunting or drowning of plants on heavy soils.

The composition of water used for irrigation is important. Chlorine, calcium, and salts must be low. Also, water contaminated with plant disease organisms should be avoided. The county agent can test the water for a grower and if it is not suitable for irrigation, it should not be used.

SELECTING SEED

Tobacco seed that is true to type should be planted. Certified seed of most familiar varieties is available and most growers obtain their seed from commercial sources.

If growers save their own seed, they should search the tobacco field for seed plants that are true to type for the variety. The advantage of selecting good seed plants will be lost if they are allowed to cross with other types. To prevent this, flower heads are covered with 12-to16-pound paper bags with waterproof glue. The tobacco flower then can self-fertilize itself without danger of pollination from other plants.

Growers should remove the small leaves and branches just below each covered flower head and attach the mouth of the bag securely to the stalk with string, wire, or staple. All open blossoms, previously fertilized flowers, and seed

PN-4314

FIGURE 76.—Irrigating burley tobacco with overhead irrigation.

PN-4315

FIGURE 77.—Drowning is associated with the accumulation of water in a low area; this causes the plants to "flop." Most plants so affected will die in a few days.

pods, must be removed before the bag is placed over the flower head. The bag must be adjusted from time to time to accommodate growing flowers and maturing seed pods. To control budworms, the seedhead should be treated with an insecticide.

It is not necessary to bag tobacco flower heads in a field that is isolated from fields of other varieties. The distance necessary will depend on the number of pollinators in the area such as humming birds, hawk moths, bees, and others, but one-half mile usually is considered adequate.

After the seeds mature, the seedhead is cut off and hung in a cool, dry place to air-dry. When dry, the seeds are threshed and thoroughly cleaned with a screen and blower. Before sowing, the seed should be tested for germination.

Parts of a tobacco flower and seed capsule are shown in figure 78.

PRECAUTIONS

This publication is intended for nationwide distribution. Pesticides are registered by the Environmental Protection Agency (EPA) for countrywide use unless otherwise indicated on the label.

The use of pesticides is governed by the provisions of the Federal Insecticide, Fungicide, and Rodenticide Act, as amended. This Act is administered by EPA. According to the provisions of the Act, "It shall be unlawful for any person to use any registered pesticide in a manner inconsistent with its labeling." (Section 12 (a) (2) (G))

EPA has interpreted this Section of the Act to require that the intended use of the pesticide must be on the label of the pesticide being used or covered by a Pesticide Enforcement Policy Statement (PEPS) issued by EPA.

The optimum use of pesticides, both as to rate and frequency, may vary in different sections of the country. Users of this publication may also wish to consult their Cooperative Extension Service, State Agricultural Experiment Stations, or County Extension Agents for information applicable to their localities.

The pesticides mentioned in this publication are abailable in several different formulations that contain varying amounts of active ingredient. Because of this difference, the rates given in this publication refer to the amount of active ingredient, unless otherwise endicated. Users are reminded to convert the rate in the publication to the strength of the pesticide actually being used. For example, 1 pound of active ingredient equals 2 pounds of a 50 percent formulation.

The user is cautioned to read and follow all directions and precautions given on the label of the pesticide formulation being used.

Federal and State regulations require registration numbers on all pesticide containers. Use only pesticides that carry one of these registration numbers.

USDA publications that contain suggestions for the use of pesticides are normally revised at 2-year intervals. If your copy is more than 2 years old, contact your Cooperative Extension Service to determine the latest pesticide recommendations.

The pesticides mentioned in this publication were federally registered for the use indicated as of the issue of this publication. The user is caustioned to determine the directions on the label or labeling prior to use of the pesticide.

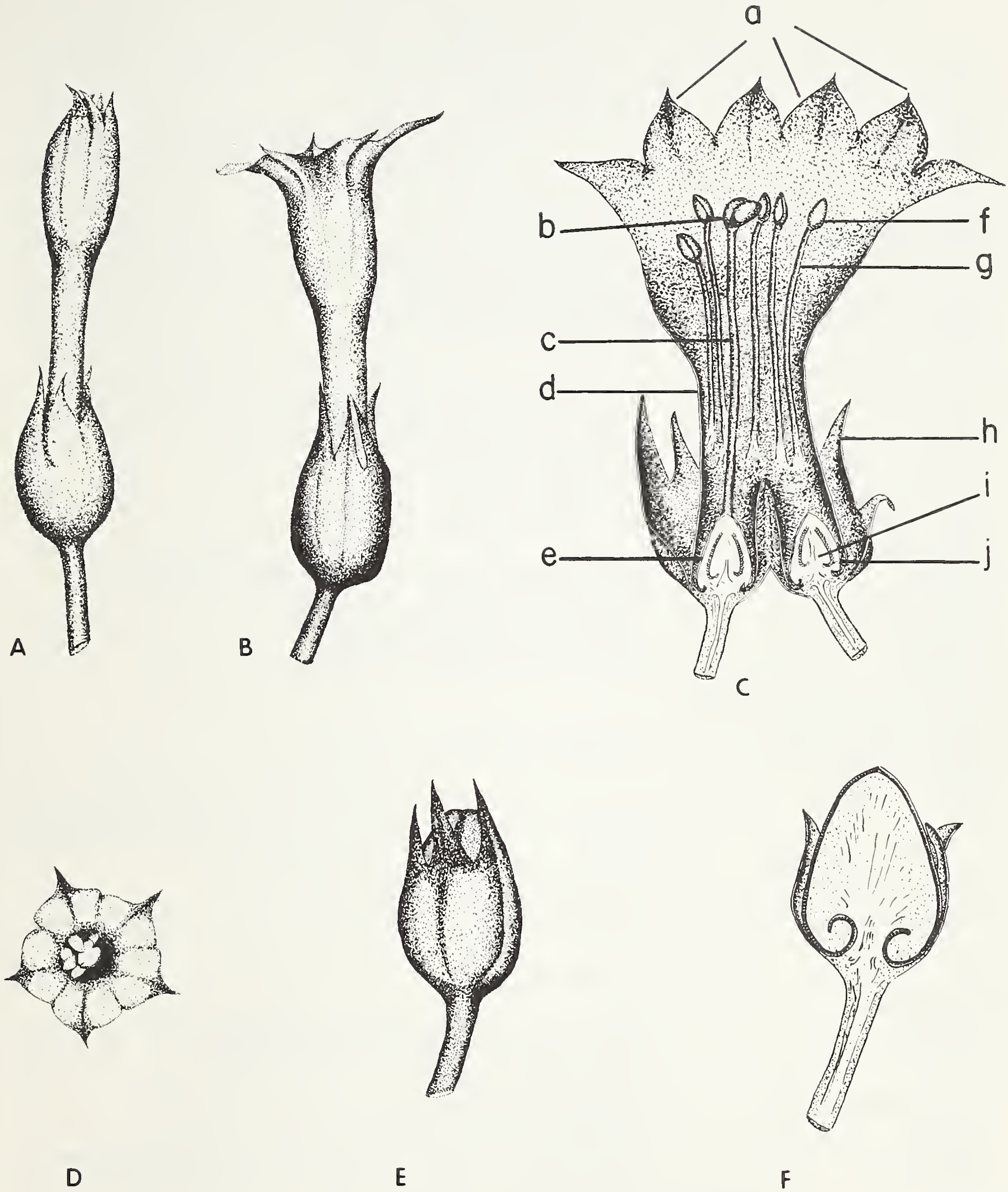


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FIGURE 78.— Parts of tobacco flower and seed capsule, magnified about 1½ times: A, unopened flower; B, open flower, longitudinal view; C, flower cut open longitudinally to show essential parts—(a) corolla lobes, (b) stigma, (c) style, (d) corolla tube, (e) ovary, (f) anther, (g) filament, (h) calyz lobe, (i) placenta, and (j) ovules; D, open flower, vertical view; E, seed pod, logitudinal view; and F, seed pod cut open logiutdinally to show essential parts. (Drawings by M. O. Neas)

APPENDIX

Pesticides referred to in bulletin

Common Name	*Active Ingredient or Chemical Name*
SEEDBEDS	
Chloropicrin	Trichloronitromethane
Dazomet	Tetrahydro-3,5-dimethyl-2H-1,3,5-thiadiazine-2-thione
Methyl bromide	Monobromomethane
Methyl isothiocyanate	Methyl isothiocyanate
SMDC	Sodium methyldithiocarbamate
FUNGICIDES (Seedbeds)	
Fixed copper	Includes the basic sulfates, oxychlorides, and oxides
Ferbam	Ferric dimethyldithiocarbamate
Maneb	Manganous ethylenebis[dithiocarbamate]
p-dichlorobenzene	p-Dichlorobenzene
Streptomycin	Streptomycin sulfate or nitrate
Zineb	Zinc ethylenebis[dithiocarbamate]
HERBICIDES (Field)	
Benefin	N-Butyl-N-ethyl-a,a,a-trifluoro-2,6-dinitro-p-toluidine
Diphenamid	N,N-Dimethyl-2,2-diphenylacetamid
Isopropalin	2,6-Dinitro-N,N-dipropylcumidine
Pebulate	S-Propyl butylethylthiocarbamate
Vernolate	S-Propyl dipropylthiocarbamate
SUCKER CONTROL AGENTS	
Fatty alcohols	Octanol and decanol
Maleic hydrazide (MH)	1,2-Dihydro-3,6-pyridazinedione
NEMATICIDES	
DD mixture	Chlorinated C3 hydrocarbons (including 1,3-dichloropropene, 1,2-dichloropropane, and other related chlorinated hydrocarbons)
Ethoprop[1] (MOCCA)	O-Ethyl S,S-dipropyl phosphorodithioate
Ethylene dibromide (EDB)	1,2-Dibromoethane
Fensulfothion[1] (Dasonit)	0,0-Diethyl O-[p-(methylsulfinyl)]phenyl phosphorothioate
INSECTICIDES	
Acephate	O,S-Dimethyl acetylphosphoramidothioate
Azinphosmethyl	O,P-Dimethyl S-[4-oxo-1,2,3-benzotriazin-3 (4H)-yl) methyl] phosphorodithioate
Bacillus thuringiensis	Crystalline toxin produced by *Bacillus thuringiensis*
Carbaryl	1-Naphthyl methylcarbamate
Carbofuran	2,3-Dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate
Diazinon	O,O-Diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate
Disulfoton	O,O-Diethyl S-[2(ethylthio)ethyl] phosphorodithioate
Focaps (Dyfonate)	O-Ethyl S-phenyl ethylphosphonodithioate

APPENDIX COND'T

Common Name	*Active Ingredient or Chemical Name*
Endosulfan	6,7,8,9,10,10-Hexachloro-1,5,5a,6,9,9a-hexahydro-6,9—methano-2,4,3-benzodioxathiepin 3-oxide
Malathion	Diethyl mercaptosuccinate S-ester with O,O-dimethyl phosphorodithioate
Methidathion	O,O-Dimethyl phosphorodithioate S-ester with 4-(mercaptomethyl)-2-methoxy-alpha^2-1,3,4-thiadiazolin-5-one
Methomyl	S-Methyl-N-[(methylcarbamoyl)oxy]thioacetimidate
Monocrotophos	Dimethyl phosphate ester with (E)-3-hydroxy-N-methylcrotonamide
Parathion	O,O-Diethyl O-(p-nitrophenyl)phosphorothioate
Trichlorfon	Dimethyl (2,2,2-trichloro-1-hydroxyethyl)phosphonate

[1]Nematicide and Insecticide

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